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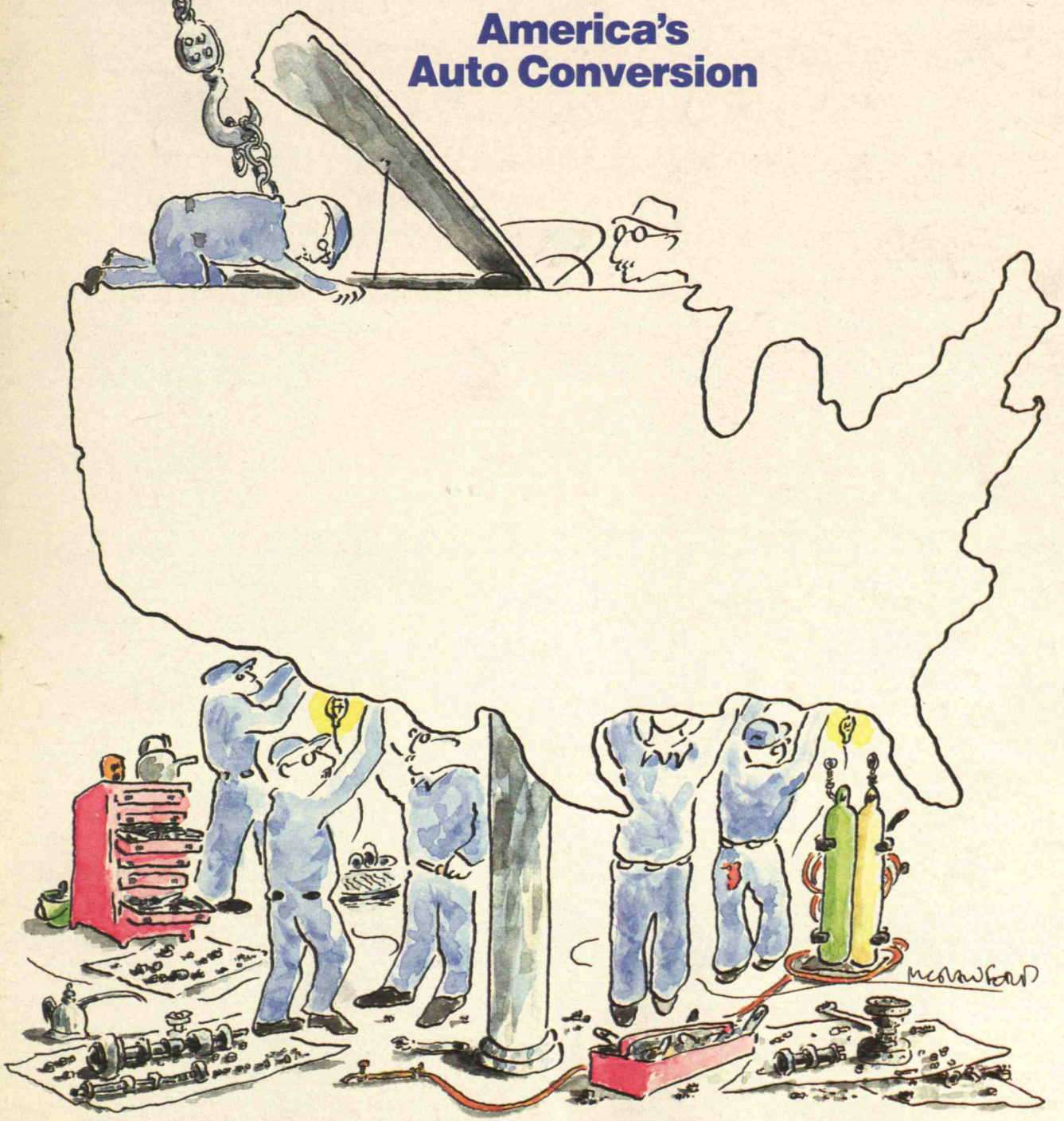
Technology Review

Edited at the Massachusetts Institute of Technology

America's Auto Conversion



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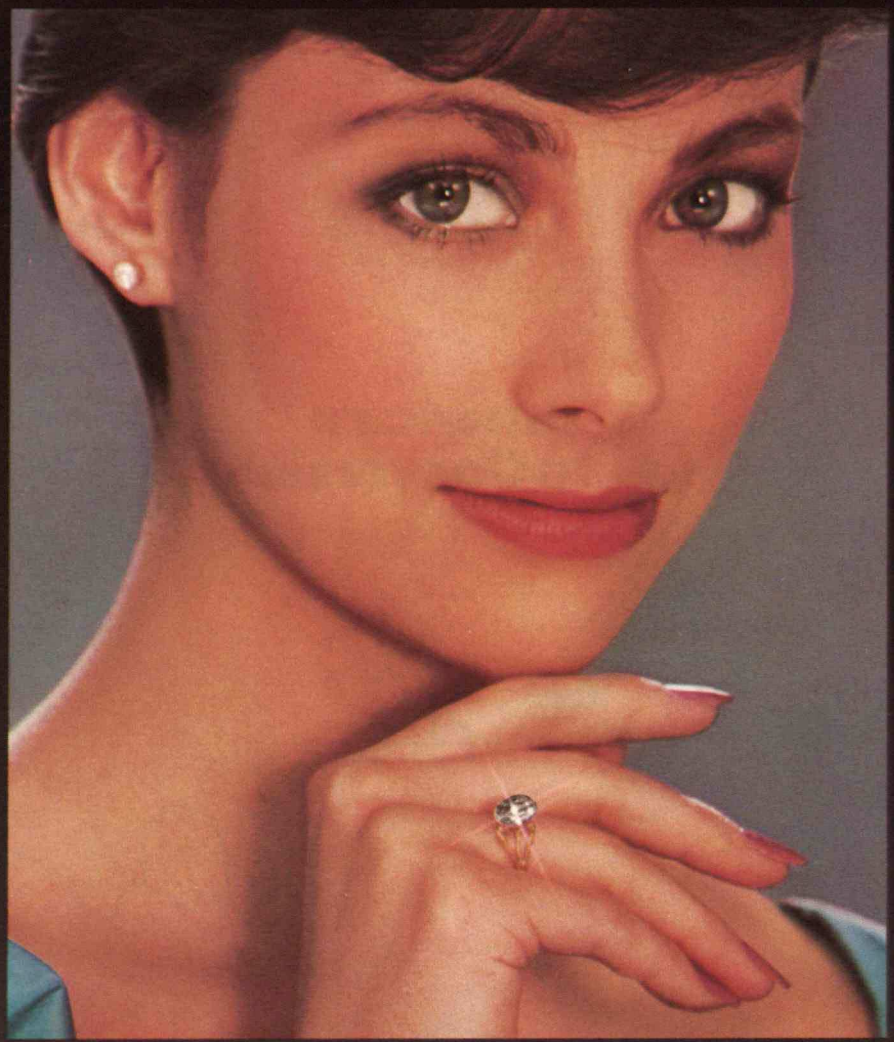
A little extra weight she won't mind putting on.



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Every diamond is rare.
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And, like love, becomes more precious with time.

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Born from the earth. Reborn on a woman.

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A diamond is forever. De Beers

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Volume 85, Number 6
August/September 1982

Technology Review

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LETTERS

Human Scales

"On Knowledge, Wonder, and World Peace: An Interview with Victor Weisskopf" (*May/June, page 48*) is by far the best statement I have encountered on the subject. It expresses my own "gut" feelings in clear scientific and humanitarian terms. I am anxious to help develop the kind of public understanding and commitment that Prof. Weisskopf advocates.
Lee S. Wilson
Olympia, Wash.

Despite his otherwise enlightened thinking, Prof. Weisskopf advocates continued development of nuclear power sources, including fusion. The concept of centralization strikes at the very heart of today's social ills: alienation and disenchantment with technology. The seriousness of the nuclear power controversy must not be underestimated. Even if nuclear plants did not produce thousands of pounds of the deadliest and longest-lived poison yearly, and even if plutonium weren't key to the production of nuclear weapons, nuclear power plants and the billons spent on them would still be the primary example of misused and dehumanizing technology.
Francis X. McConville
Worcester, Mass.

More for Risk Analysis

Samuel C. Florman's "Risk Analysis and the Congressman-Engineer" (*February/March, page 12*) illustrates the confusion surrounding this subject and the need for *proper* analysis. The fact that a risk calculation is uncertain does not make it useless.

For example, according to Supreme Court statistics, the proposed cotton dust standard will reduce cases of brown-lung disease at a cost of about $100,000 per case. This is far less than the $10,000,000 per life saved that is the standard limit for occupational protection. By this comparison, the new standard is obviously worthwhile. This elementary analysis suggests that if the Supreme Court had insisted that the cotton-dust regulation be based on such calculation, the Occupational and Safety Health Administration might have set an even tighter standard.

Mr. Florman and others should stop trying to discredit the risk-analysis process and try to understand and improve it.
Richard Wilson
Cambridge, Mass.

The writer is professor of physics at Harvard University.

Mr. Florman completely misses the point: failure to use risk analysis in governmental decision making has been an unmitigated disaster. For example, we are spending hundreds of millions of dollars per life saved to protect ourselves from some hazards, while failing to save lives at costs well below $50,000 each where other hazards are involved. This insanity is killing thousands of people and wasting billions of dollars every year. Surely it is better to use risk analysis, in spite of its imperfections, than to allow this inequity to continue.

Although there are uncertainties in present risk-analysis methods, it would not be difficult to reach a consensus in the risk-analysis community on costs versus benefits in many situations. For the health effects of radiation, which is one of Mr. Florman's examples of an area where knowledge is insufficient, all prestigious national and international committees agree within 20 percent on the best values to use.
Bernard L. Cohen
Pittsburgh, Pa.

The writer is professor of physics at the University of Pittsburgh.

Energy Transition and the Free Market

John Tirman's "Investing in the Energy Transition" (*April, page 64*) screams for a rejoinder. Industry's energy costs are significantly higher than direct energy costs for retailers and homeowners. Thus since 1973, the industrial sector has been motivated to achieve a far higher level of energy conservation than the commercial and residential sectors.

Mr. Tirman believes that decontrol of crude-oil prices has been largely a matter of luck—to which I say: let's decontrol natural gas and maybe we'll get lucky again.
Terrence K. McMahon
New York, N.Y.

Mr. Tirman claims that in 1979 electric utilities invested $64 billion in new equipment, a figure more than double that recorded in the McGraw-Hill Summary of Electric Plant Construction. He goes on to say that the electric utilities "anticipate borrowing $750 million" from 1981 to 1990.He must mean $750 billion, though I have seen no forecast indicating total

spending of more than $30 billion per year for the next ten years.

Landlords have as much incentive as any other group of property owners to conserve energy—they can increase their net income by cutting fuel costs. And landlords know that when tenants pay the fuel bills, they always ask about fuel expenditure before renting the property. Where utilities are cheap, tenants are willing to pay more rent. The logic of the free market works for energy conservation as it does elsewhere.
P.D. Schaeffer
Cleveland, Ohio

Mr. Tirman goes on to argue that homeowners and small users are unable to finance wood stoves. The data I have seen indicate phenomenal growth in the sale of woodstoves. The marketplace must be working very well if growth in demand for electricity has fallen from an annual rate of 7 percent during the 1960s to 0 to 2 percent today.
Thomas R. Casten
New York, N.Y.

Mr. Tirman responds:
The wood-stove assertion was the misfortune of a lengthy editorial process and my hasty proofreading. However, the best stoves and home furnaces—which may cost several thousand dollars—may be beyond the reach of many households.

Figures on the capital investment of utilities can be found in *Statistics of Privately Owned Electric Utilities in the United States, 1979* (Department of Energy, October 1980) and its companion volume for public utilities. The ten-year utility investment forecast of $750 *billion* is common (*see the* Wall Street Journal, *February 2, 1981*).

Energy costs and accounting vary greatly within all sectors, and cross-comparisons are misleading. An individual's energy costs may easily reach 15 to 25 percent of after-tax income, a substantial burden. It is true that industry has conserved fuel most aggressively, which confirms my institutional analysis: large corporations aren't more "rational" than small-business owners or homeowners, only wealthier.

I am still skeptical of the free market's capacity to usher us efficiently into a post-petroleum age. I do not suggest that the end of price controls is unimportant. Markets are always preferable when they work smoothly, but they rarely do. We need to supplement the market to promote technological innovation—particularly through financing—to make the long transition to renewable energy supplies less costly and painful than it otherwise will be.
Mr. Schaeffer clearly has not looked for an apartment in the last few years. Housing markets in major cities are very tight, and renters are likely to have higher priorities than fuel costs, such as size, location, schools, and security in choosing apartments.So the landlord's "incentive" to save fuel is marginal at best. This is another case of how an exclusively "market" approach to conservation is sadly flawed.

When the Economy Relaxes

Thank you for emphasizing our continued dependence on imported oil in "Tense Times When the Oil Runs Out" (*May/June, page 78*). The United States should be prepared for any future disruption in its petroleum supply. While our dependence on imported oil has lessened, we remain vulnerable because current imports are still 30 percent of supplies. Reduction of imports is directly related to the state of our economy. Thus, imports could rise if our economy turns for the better.
Jim Westberg
Phoenix, Ariz.

Terms and Terminology

Dr. Boulding's "guestage" program (*"Undoing Doomsday," May/June, page 8*) reminds me of an idea I had while serving the military establishment. Sons, daughters, nieces, and nephews of the president, Cabinet members, joint chiefs of staff, and members of both houses of Congress should be drafted to staff a small number of units in the four military services. These "very selective service" units would be by law the first ones sent to combat abroad in support of American foreign policy.
W.R. Corcoran
Windsor, Conn.

Nearly 30 years ago, a proposal similar to the "guestage" exchanges was advanced. It was suggested that a Soviet armored division be stationed within striking distance of the Pentagon, and an equivalent U.S. division be stationed within range of the Kremlin. Perhaps this idea and the guestage program should be combined.
Robert W. Perkins
Newington, Conn.

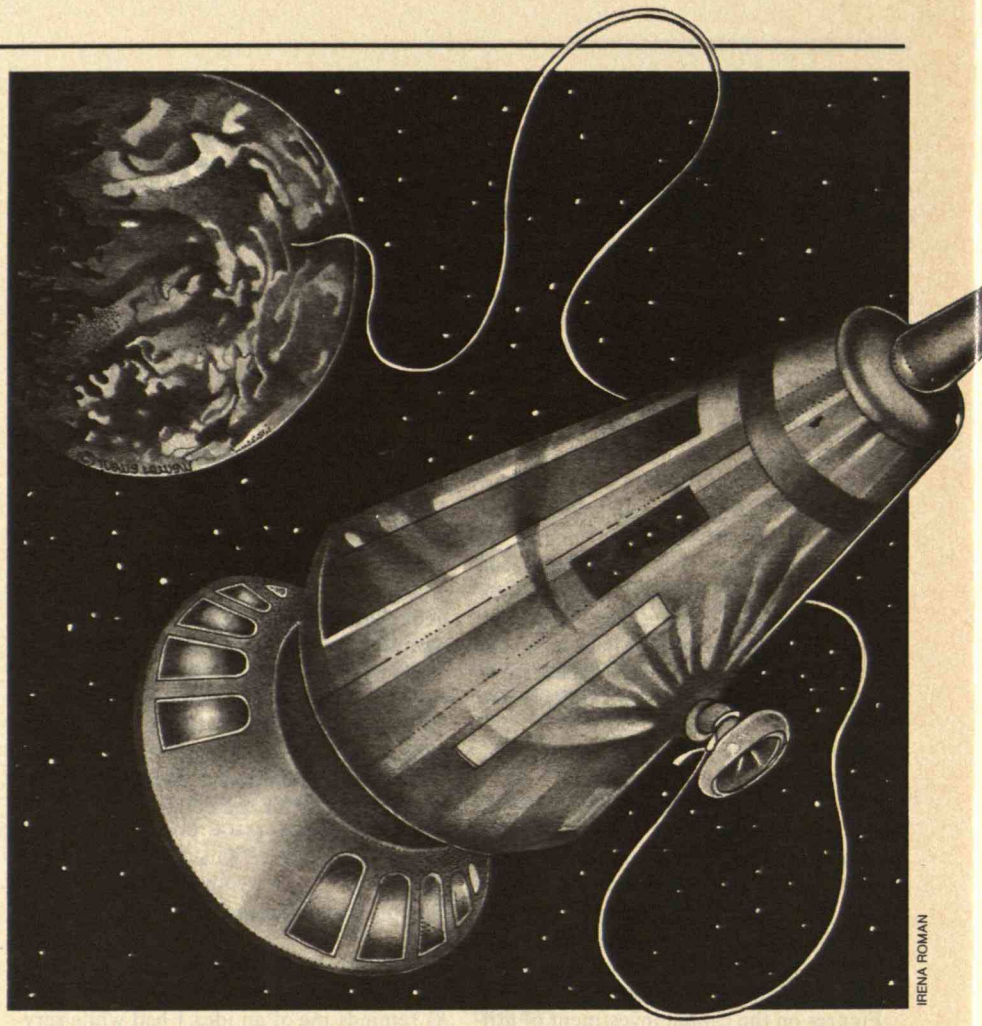
I endorse Prof. Boulding's recommendation for the "abolition of national defense as a world system" (*"Appropriate Strength," February/March, page 8*). I also agree that words with ambiguous meaning "are particularly prone to produce agreement." To "strong" and "appropriate," I would add "affordable," as used to discuss real estate, automobiles, and even weapons systems. It is a beautiful example of a word used to achieve agreement, yet who knows what it means?
Harold Tarkow
Madison, Wisc.

Errata

In our chronology of robotics in May/June (*page* 42), *Technology Review* erroneously assigns to Unimation, Inc., the design of a "domestic robot system" included in the Nieman-Marcus Christmas catalog for 1981. The device was, in fact, designed and built overseas. We regret the error.

Robert Cowen

Soviet Rockets Wear UFO Masks



IRENA ROMAN

ONE of the minor anomalies of Soviet life is the genuine ignorance of many scientists and other highly placed citizens concerning their own space program. It is no wonder that some of the most spectacular Russian—and recently South American—reports of unidentified flying objects (UFOs) have been linked to secret Soviet rockets.

They are launched from the northern spaceport at Plesetsk about 200 kilometers south of Archangel. The Soviet government has never acknowledged that this "cosmodrome" exists. While Western experts and space buffs are aware of it, only those Soviet citizens with a direct "need to know" share the secret. Most, if not all, of the others do not appear even to suspect its presence. That is why Soviet astronomers and other competent observers are unable to trace clear and often detailed UFO sightings to rocket launches. They then may indulge in speculation about extraterrestrial visitors that makes headlines in the Western press and helps the Soviet government keep its space secrets.

This confusion underlies some of the most dramatic UFO events of the past two years. What have appeared to be giant luminous objects have been seen passing over both South America and the USSR since 1980. Other reports, sparked by these sightings, tell of UFOs chasing cars, communicating through mental telepathy, disrupting television, and even sending out scout ships whose alien crews are plainly visible.

What has actually happened is that the Soviets established an early warning satellite network to keep tabs on U.S. rocket launches. The Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP) reported in June what it considers to be conclusive proof that those UFOs are early-warning satellite launches from Plesetsk. CSICOP is an organization of experts and laypeople who use their own time and resources to check out claims of the supernatural and other far-out phenomena.

This study was made for CSICOP's UFO subcommittee by Philip Klass, senior avionics editor at *Aviation Week & Space Technology* magazine; Robert Sheaffer, free-lance science writer; and James Oberg, who is with the NASA-Johnson Space Center at Houston. Mr. Oberg is the most knowledgeable Western authority on the Soviet space program outside of official intelligence agencies. It was his expertise that enabled the team to extract a meaningful signal from the UFO noise.

Robert C. Cowen is science editor of the Christian Science Monitor *and former president of the National Association of Science Writers.* □

Disrobing the Ghosts

Mr. Oberg has been following Soviet-inspired UFOs for a long time. He points out that the Soviet government officially disapproves of speculation about visitors from outer space. But since it won't own up to the space shots that underlie such speculation, it finds the flying-saucer myth a convenient deception.

One notable UFO flap was set off in 1967 by the reentry of dummy warheads during tests of a fractional-orbit bombardment system. Mr. Oberg says: "Moscow was no doubt pleased with this case of mistaken space identity, since it had just signed a treaty outlawing such weapons and had no desire for its ongoing illegal tests to be recognized for what they really were—first-strike space-to-ground weapons."

Then there was the great "jellyfish UFO" of September 20, 1977. A frightening apparition looking like a monstrous luminous jellyfish suddenly appeared over the city of Petrozavodsk, which lies between Leningrad and Plesetsk. It was described by Tass correspondent Nikolay Milov as "showering the city with a multitude of very fine rays that created an image of pouring rain." The UFO was later seen over Leningrad and Helsinki.

This report caused a sensation in parts of the Western press, with one headline announcing "the first UFO to inflict damage on a city." Other reports told of holes drilled in paving stones and through windows by the UFO's rays. Subsequent reports said that the purported spaceship "hung in the night sky for at least two hours at an altitude of 60 miles." It was said to be "the center of a great activity as

much smaller bodies appeared to dart away from it, while others seemed to approach and disappear into immense portholes."

Mr. Oberg has firmly connected the "jellyfish" with the launch of *Kosmos-955*, a spy satellite, from Plesetsk. Using tracking data from the NASA-Goddard Space Flight Center and the North American Air Defense Command, he found that the launch at 3:58 A.M. local time and the flight trajectory easily accounted for the UFO. This fact was soon confirmed by some UFO research groups in the United States. But as Mr. Oberg recounts in the December 24-31, 1981 issue of *New Scientist*, the tale of the "jellyfish UFO" lives on and grows ever better with the telling. Anyone interested in the interplay of fact and fiction that characterizes the UFO scene should look up that article.

With that experience behind him, Mr. Oberg was more than a little suspicious of the glowing UFO globs that began appearing over Argentina and other parts of South America in 1980. First reported over the Soviet Union, the glowing clouds would be seen over South America about an hour later. That is roughly the flight time for a rocket launched eastward from Plesetsk. Such a launch puts a satellite into an orbit whose inclination to the equator is the same as the latitude of the launch site. The ground track of the glowing UFO, as established from the sites over which it passed, was about 62.8 degrees. That seems too close to the Plesetsk latitude of about 62.7 degrees north to be merely coincidental. Likewise, the launch times of two Plesetsk early-warning shots—*Kosmos 1188* and *Kosmos 1317*—coincide with the timing of two spectacular UFOs. These were, respectively, the flying saucers of June 14, 1980 and October 31, 1981.

These early-warning launch vehicles are multiple-stage rockets. Their injection into a higher orbit followed by their dumping of excess fuel can easily have caused the South American sightings. Mr. Oberg explains: "The Russian observers on June 14 merely saw the booster trails backlit by the midnight sun, as the rocket climbed up from the spaceport at Plesetsk. An hour later, it was early evening in South America and the rocket's fuel cloud was lit by the sun because of its high altitude."

There seems little doubt that the CSICOP team has correctly identified these and related UFOs. Whether a cloud of jettisoned fuel is the main explanation for what appeared over South America is not so well established. Mr. Oberg says the cloud effect, at least in some cases, may be due to other causes as well—such as explosive separation of the satellite from the final booster stage.

Facing the Real Monster

As Oberg himself points out, there are several conclusions to be drawn from this UFO saga. First, it seems apparent that the Soviet Union has moved from testing a smaller-scale early-warning system into developing a major operational network. There were no more than three early-warning satellites, launched at a rate of about two per year, operating at a given time from the program's start in 1972 until late in 1980. Then in 1980, six were launched followed by six more last year. The earlier vehicles did not orbit over South America at times when sun angles favored sightings. But two satellites launched during 1980 and 1981 did appear at favorable times to set off two sensational UFO events.

One can also conclude that it pays to take UFO reports seriously—especially those from widely separated areas—however bizarre they may seem. Observations from both the USSR and South America, some of which were made by astronomers, helped pin down the ground track, altitude, and other salient details of the UFOs that led to successful identification.

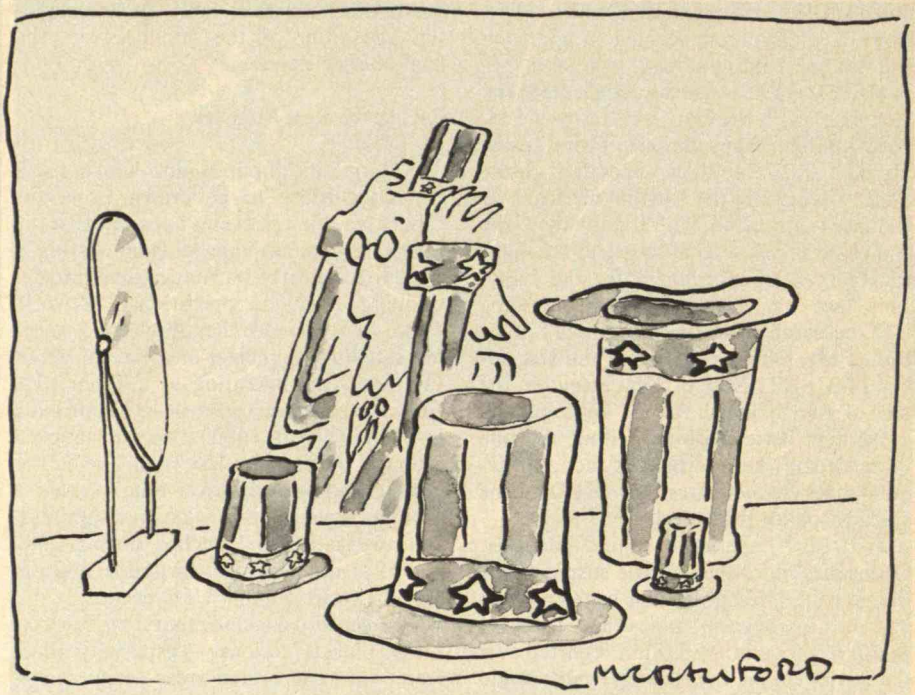
It is tempting to dismiss the charge made by UFO buffs that intelligence agencies have secret files on UFOs that they are reluctant to release. Most such material, when it is made available, contains no revelations on alien visitations. But it undoubtedly does pay such agencies to sift through UFO reports for any light they can shed on Soviet space secrets. To the extent that this process involves classified techniques, intelligence agencies probably—and properly—are withholding UFO information.

Finally, what about all those scout ships, car chases, and disintegrator rays? As Oberg notes in the CSICOP statement: "Since we know for sure the real stimulus for the original sightings, we can recognize these other features for what they are—exaggerations, fantasies, and fabrications."

Once again, a hard-headed UFO study has shown that this seemingly goofy subject deserves serious ongoing research. UFOs are as real, and as significant, as the secret space shots and other genuine mysteries that underlie reliable sightings. At the same time, we are reminded that claims of close encounters of the third kind and other signs of alien visitors are most likely to be "exaggerations, fantasies, and fabrications." □

Kenneth Boulding

The Role of Government in a Free Society



I recall from my childhood the image of an anarchist as someone who did not believe in government but who was holding a bomb. One is tempted to label the present administration in Washington "the first anarchist government in the United States." There are moments when it certainly seems to wish to dismantle all federal government except the bomb, in which case the only role of government would be to destroy people. I recognize this as an absurd caricature, but sometimes caricature is the ultimate expression of truth.

The present administration reflects the genuine unease of a considerable portion of the American people about the role of government in what we hope is a free society. Some of this unease is legitimate. One could say that the founders of the United States regarded government as inherently bad and devised a constitution to prevent it through the separation of powers. In the process, oddly enough, they produced a society that was much more monarchical than that which developed in the British countries. Certainly George III would have given his eye teeth to have the powers of the American president. Nevertheless, the Constitution, however clumsy, does work, as demonstrated by the Watergate case and some presidential vetoes, Supreme Court decisions, and congressional overridings.

But many Americans still have the uncomfortable feeling that government, if not quite a cancer, is at least an internal busybody that tends to get out of hand, interfering with private lives and pleasures. Ironically, in spite of this feeling, there is little evidence that government has expanded unduly, for total government has constituted a relatively stable percentage of both the gross national product and the labor force ever since 1950. Even more ironically, state and local governments have actually grown at the expense of the federal government!

This growth has reached the point where state and local governments are running into restrictions such as Proposition 13 in California, or the preposterous limitation on increases in state government expenditures to 7 percent annually in Colorado. The federal government is now pushing responsibilities it can easily assume onto state and local governments, which are substantially overburdened. Nevertheless, most civilian government has been conducted at the state and local levels, where people are presumably closer to those who make decisions (ostensibly on their behalf) and participation is theoretically easier.

Kenenth E. Boulding is a project director with the Research Program on Political and Economic Change, Institute of Behavioral Science, and distinguished professor emeritus of economics at the University of Colorado at Boulder.

Public Goods and Private Bads

The central question remains: what role should government play in a society that values personal freedom, private property, and private initiative, even when the economy has become increasingly quasi-public in the form of large corporations? General Motors, after all, is about as "private" as the state of New York, in the sense that the managers' decisions affect equally large numbers of people.

Economists, of course, have something to say about this matter and hesitate very little to say it. According to them, government is necessary because there are public goods and private bads. Public goods are those that the market cannot supply because they cannot be appropriated, but it is not always easy to say which goods these are. The usual example of a public good is national defense, which has now turned into a "public bad." Streets and roads are a better example. Hardly anybody would advocate turning all streets and roads into private property to be paid for through turnpikes. Parks are another example. Certainly Manhattan would be a much less agreeable place without Central Park.

Education is also an excellent example. One would have to be a very rabid anarchist to want to turn all education back to the private sector. On the other hand, one could certainly argue that higher education is much more a private good than a public good, and perhaps should be financed by a system of educational banks rather than through the public purse. Still, there is something to be said for public splendor, such as capitol buildings and state universities. Pride in the community is by no means a negligible public good.

The reduction of private bads is another well-recognized objective of government. This role involves the discouragement of crime—murder, theft, and so on—most of which is a private attempt at redistribution of wealth. Economists recognize more subtle forms of private bads in the form of "externalities"—the consequences of private decisions that do not affect the welfare of the decision maker. Externalities may be either goods or bads. A man who plants a beautiful garden in his front yard may give pleasure to all passersby, but he cannot

charge them for it. A man who makes his front yard a dump cannot be charged by the passersby, either.

Pollution is a classic example of a bad externality. Almost all production processes yield both goods and bads. There is a strong temptation to keep or sell the goods and to throw the bads somewhere else. Air and water pollution are examples of bads that private property and markets cannot deal with suitably, except in certain cases where they can in fact be appropriated.

Much government regulation consists of redefining property to create ownership of bads. One very ingenious example is the proposal to solve river pollution by penalizing people who take water from a river above where they discharge it. Then people would have to pay for their own pollution and would have very strong incentives to clean it up.

Not Less, But Better, Government

These problems can easily become too difficult for government to handle—and clumsy attempts can do more harm than good. The more powerful a decision maker, whether in government, corporations, or even the church, the less likely he or she is to suffer the consequences of the decisions and the more pollution will be produced, whether physical, informational, or spiritual. For example, a bad decision on the part of the Federal Reserve Board can create bads for millions of people who lose their jobs, cannot finance their houses, and go bankrupt. Because we cannot establish property rights in our total environment, either physical or social, it is hard to devise redress—either through the market or the courts—for bads imposed on us by others.

We try to solve the problem of accountability with devices such as elections and political parties. While certainly better than nothing, these devices are still a far cry from solutions. Increasingly, we seem to be trying to solve these problems through costly channels such as civil law and damage or malpractice suits, which can produce some unforeseen results. When payoffs to the litigious and the fussbudgets increase, and are denied to the great common masses who put up with things and get on with their work, one worries about the costs of law to society. When litigation becomes as widespread as it is in the United States, one worries about its being a cancer.

The problem with specialization is that legislators feel that they have to produce legislation, just as soldiers have an urge to get into fights, whether or not either of these activities makes any sense. Thus, each session of a legislature adds new laws and regulations. The sense that we are overregulated and overtaxed arises because both regulation and taxation are a great stalagmite of accumulated droppings, the ultimate effects of which are increasingly hard to fathom. I have yet to find economists who would dare say that they really understand the effect of the tax system on the economy, or even the ultimate effects of the regulatory system.

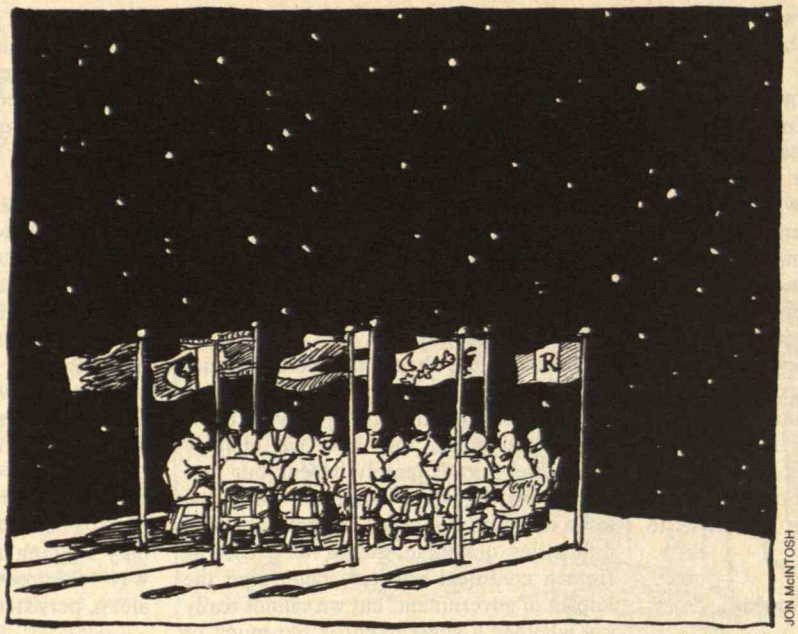
Obviously, we should tax the unproductive and favor the productive, tax economic rent if we can find it, and tax income that is clearly unearned. But how we identify these categories is largely beyond our present knowledge and wisdom. Much the same could be said about regulation. These difficulties, of course, should not excuse us from a continual effort to determine the impact of government, but we cannot really say whether a government is too much or too little until we know of what kind. The answer to bad government may not be less government but better government, and a mere prejudice against government as such can easily divert our attention from the real problems of qualitative examination and change.

Perhaps our greatest ignorance is in the distributional impact of government—who is benefited, who is injured, and who is unaffected by any particular law, regulation, or tax system. Although this is difficult, we certainly need to investigate the various impacts more than we have done. I have argued for "distributional impact statements," which would spell out who is affected, and roughly how much, by any particular act, regulation, or even organization. I have to confess that I would hate to have to research and write such a document. There seem to be no golden answers, only niggling questions. Probably the only way to improve government is to niggle along, persistently. □

Meeting in Vienna: Politics in Space

by David C. Webb

AFTER several years of negotiation and considerable last-minute controversy, the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space—better known as Unispace 82—will take place in Vienna, Austria, from August 9 to 21. Unlike the first U.N. space conference held in 1968, when the rest of the world listened respectfully as the two space powers discussed their exploits in this "new" arena, Unispace 82 promises to have global participation.



JON McINTOSH

Representatives from nearly 150 nations will grapple with how humanity will deal institutionally—now and in the future—with operations in this emerging frontier. They will ask questions such as: Where does space begin? If all nations can operate unhindered in space, who controls its resources? If one nation's satellites scan another nation without permission, does that nation have the right to use the information unilaterally or should it be shared? Can data be passed to a third party without consent? Should an international body be formed within (or outside) the United Nations to establish international rules covering such questions? Does the recent introduction of antisatellite weapons presage a major armaments race in space, or can this frightening prospect be stopped before it develops into a Star Wars scenario?

Space faring is extremely expensive and thus both economically and technically beyond the means of many nations. Yet all nations are space travelers together. Is it fair, then, that because of mere historical accident some should not share directly in the benefits of space? How might the benefits be divided, and who will ensure an equitable division? Indeed, who will ensure, and how, that the resources are developed in the first place?

David C. Webb, who holds a Ph.D. in international development education from the University of Pittsburgh, is chairman of the Non-Governmental Organizations Conference at Unispace 82.

Concerns Center Stage

Much has changed since 1968. Not only have numerous nations produced their own satellites and launch vehicles (Canada, China, Japan, West European nations, India, Indonesia, and Brazil), but there is even greater understanding of what operating in space will mean for the development and well-being of people on Earth.

New technology emerging over the last decade is mainly responsible for this awareness. Remote sensing satellites such as Landsat already provide invaluable information on mineral resources, topographic details, and other factors essential to land use and agriculture. Experimental communications satellites, such as NASA's ATS-6, have demonstrated the possible uses of direct-broadcast satellites, offering the promise that developing nations may improve education and communications without having to construct the costly infrastructure built up over a long period by the industrial countries.

It is no accident, then, that the developing nations pushed hard for this second space conference. At the same time, they are frustrated that much of the control over the promise of space rests with the technologically advanced nations who, they perceive, may use it to their own advantage.

To the developing nations, Unispace 82 represents the opportunity to air their demands to be included in planning future uses of space. They want to see tangible meaning given to the concept that space is the common heritage of humankind. The United States argued with the Soviet Union for seven years that this concept should be included in the 1979 U.N.-negotiated Agreement Covering the Activities of States on the Moon and Other Celestial Bodies—commonly called the Moon Treaty. But after winning the point, the United States then refused to ratify the treaty.

Such actions worry the developing nations, who perceive the real issues in space utilization to be political rather than technical. While past experience has convinced them that it is precisely the political issues that are so often glossed over in United Nations conferences, they hope this will not be true at Unispace 82. It is up to the industrial nations, particularly the United States, to ensure that these questions receive proper consideration—not only because they deserve discussion, but also because U.S. interests will not be served by alienating the developing nations.

The United States must recognize that in space-related questions, the United Nations, through the International Telecommunications Union (ITU), has real teeth. For example, the ITU allocates orbital slots and wavebands for communications satellites. Since the United States manufactures, launches, and uses most of the world's communications satellites, it behooves us to tred gently. This is especially true because the ITU-sponsored World Administrative Radio Conference (WARC) has slated a regional meeting for 1983 to allocate direct-broadcast satellite orbits and wavebands for North and South American nations. And in 1985, WARC will begin a complete review of the global allocations process.

Many of the delegates attending Unispace 82 will also represent their nations at the WARC meeetings. Thus, the attitude of "let them go hang; we'll launch where we please" originally adopted by some U.S. officials was risky. The United States cannot afford to become an international communications pirate just as it is becoming more and more dependent on the free international flow of information.

The "go-hang" attitude was most prevalent in 1981 because of a disagreement with the Soviet Union over personnel assignments in the U.N.'s Outer Space Affairs Division. To show that it meant business, the United States not only pulled out of the U.N. Committee on the Peaceful Uses of Outer Space (a legitimate move under the provocative circumstances), but also pulled out of Unispace 82 to "punish" them further. This offered the Soviets an unopposed opportunity to explain to the world just how international their program is and how obviously chauvinistic ours is—a strange punishment indeed!

Fortunately, common sense prevailed and the United States returned to the fold in January of this year, when a compromise personnel agreement was negotiated by outgoing U.N. Secretary-General Kurt Waldheim. Despite concern that time was very short, the State Department and NASA put together a solid team for preconference meetings in New York, and apparently the United States will field a high-powered delegation, led by NASA administrator James Beggs, in Vienna.

The United States appears to be pulling another rabbit out of the proverbial hat, too. The Austrian government invited all nations to show their space wares at a huge exhibition accompanying Unispace 82. The Soviet Union, the major European nations, and Japan have all prepared large displays. Until April, however, it appeared as if the United States would be represented only by a restricted-budget display prepared by NASA. Given the government's previous indifference toward the conference, the major U.S. aerospace corporations stayed away in droves. But all this changed overnight when the White House summoned corporate executives and explained that it was in the national interest to mount an exhibit that does justice to our position in space technology. The result: a flurry of activity that will yield a greatly expanded U.S. presence at the exhibition.

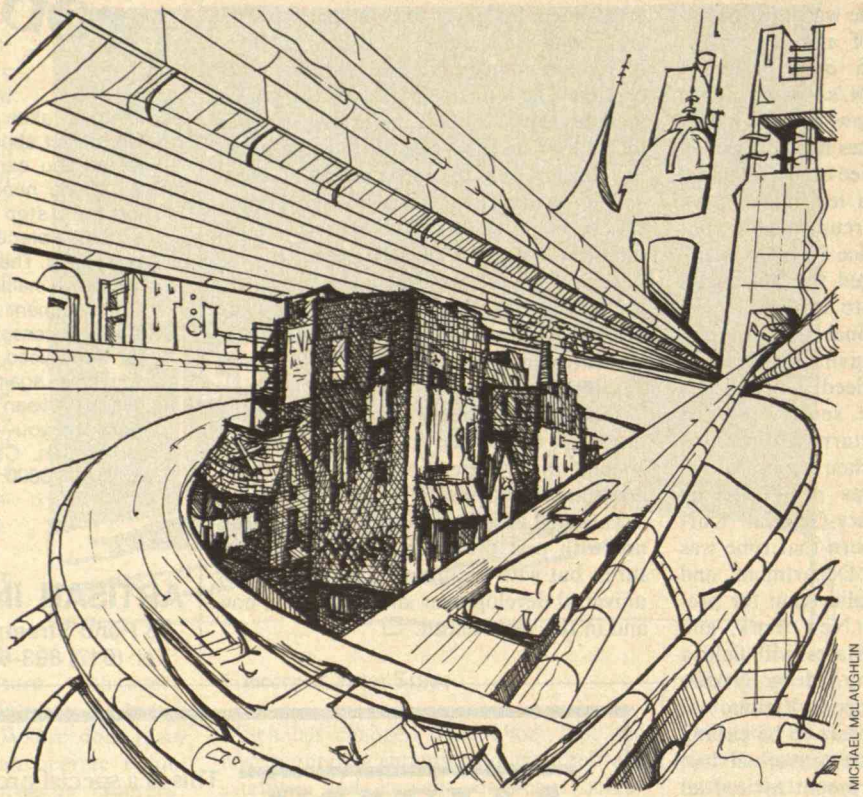
Last, but by no means least, a parallel conference will be run by the nongovernmental organizations (NGOs) affiliated with the United Nations, according to the usual practice at major U.N. conferences. The main conference can be attended only by governmental delegations, but the NGO conference is open to representatives of all the world's nongovernmental organizations—ranging from huge service groups such as Rotary International to the smallest community action groups—and, in practice, to the public generally.

Controversial issues, often glossed over or avoided by governmental participants, are usually discussed in depth at these NGO conferences. Vienna will be no exception. The ten-day agenda for the NGOs includes topics such as the impact of space technology on the Third World, the growing concern over the introduction of weapons into space, the political and legal implications of privately owned remote-sensing satellites, the role of the new (mainly American) space entrepreneurs in opening up this frontier, the pros and cons of using direct-broadcast satellites for education, and future innovation possibilities in space development.

Discussion of these and other such issues promises to provide an exciting time in Vienna this August. Most U.N. conferences are aimed at solving world problems. What sets Unispace 82 apart is that it deals not with past problems or calamitous futures, but with unlimited opportunities for universal development and prosperity, now and in the years ahead. □

Technology and the Poor

by Lewis H. Spence



MICHAEL McLAUGHLIN

When people consider the social impacts of technology, they generally either exclude the poor or presume that they will tag along behind the rest of us, after an appropriate interval to allow for the viscosity of "trickle-down" processes. The world of the poor is not thought to reflect much of technology's impact on the larger society.

The transforming power of science and technology is immediately evident in communities sharing in the material abundances they undoubtedly provide. But these effects—especially the enhanced freedom and power that such abundance brings—divert attention from less evident transformations induced by science and technology in the community's aesthetic, moral, and political life. In contrast, in poor communities, where there is less material novelty, the impact of science and technology is more starkly revealed—as degradation.

Rush of the New

The "aesthetic life" of a community includes the whole of people's relationship to things, particularly humanly created things. Today we are seeing a fundamental change in the dominant aesthetic in American culture—from an older pretechnological aesthetic to one posited on technological abundance.

The earlier aesthetic was based on satisfaction in the humanizing of things through familiarity and intimacy. Things became companions, and in sharing our lives took on a part of ourselves. This aesthetic values the old, the familiar, the beloved.

This traditionalist aesthetic we hardly know. For a technological society finds satisfaction in novelty, in what I would call, using a term from the drug experience, "the rush of the new." In a society in which things are abundant and short-lived, people take satisfaction in the temporary elation that comes with the acquisition of new objects. And we must regularly acquire new things to renew that readily exhausted elation.

Whatever this transformation may mean for the rest of the society, it has a devastating consequence for the poor. For the triumph of an aesthetic of novelty means that the poor are excluded from the dominant values and experience of the larger society. Even though the poor own only a few things, they certainly can share in an aesthetic that values the familiar and beloved—but they are precluded from the constant acquisition required by the new aesthetic.

The lives of the poor today give painful evidence of this quandary, and I have seen three responses. Some few, mostly old people, hold onto the traditionalist aesthetic. One enters the small, sterile apartments of people in elderly public housing and finds the rooms filled with heirlooms, long-preserved objects, and things that carry the memory of former lives. Yet the very contrast between these apartments and the "contemporary" aspects of adjacent common rooms and areas heightens the anachronism of the preservation of familiar and beloved things.

In other cases, poor people attempt to share in the dominant aesthetic by emulating their more affluent peers. With what little resources they have, they buy numerous cheap things, their poverty further foreshortening the durability of what they acquire and reinforcing the urgency of repetition. Even then the sharing in the dominant aesthetic is usually limited to small segments of their lives, most often clothing. The attempt is inherently frustrating, and thence, demeaning.

The most common response to aesthetic exclusion is the most frightening: alienation from things as expressed in destruction. Having no access to the only form of human satisfaction in things considered valid by society, the poor, especially the young poor, simply destroy things. To the affluent, the destruction by the poor of their own environment seems inexplicable. It is only comprehensible as evidence of the degradation of the aesthetic life of the poor.

How is the moral life of poor communities altered by the current rapid pace of technological change? Many argue that technologies are inherently neutral, but even if true, this is itself the source of moral crisis in culture. The moral life of a community reflects the relationship of each person to other individuals. New technologies generally provide human beings with new or enlarged powers, whether of destruction, as in military technologies, or enhancement of life, as with medical technologies. But these enlarged human powers create moral quandaries: they represent uncharted territory in the life of the community.

Rapid technological change causes the expansion of such morally uncharted territory. However, the evolution of consensus on the appropriate moral principles to govern these new human powers is rarely so swift. The result is moral crisis.

Moral crisis need not of itself be experienced as degradation. Indeed, for many our present moral crisis is experienced as liberation. For those who commonly exercise

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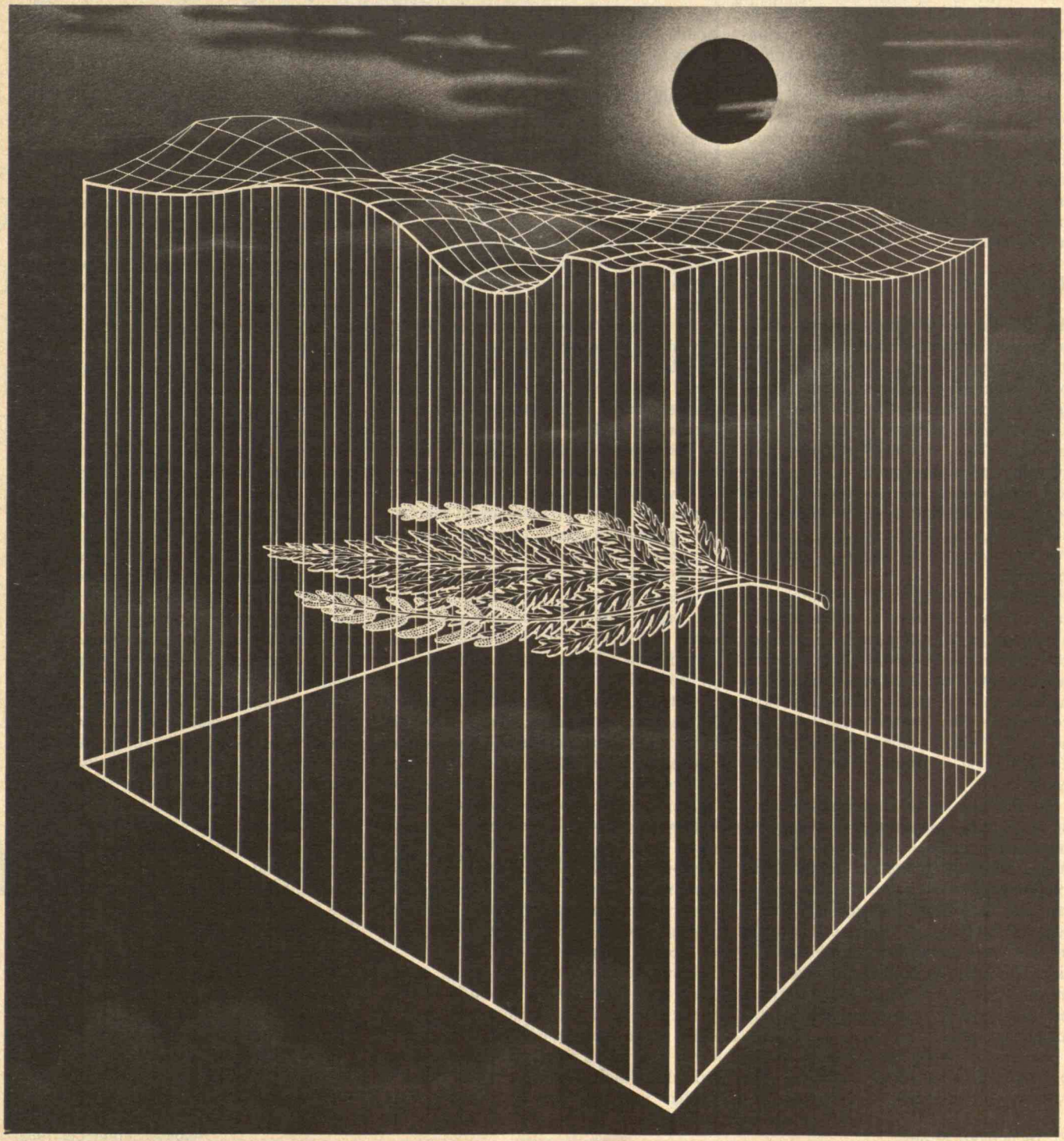

power—that is, the privileged—the discovery of new or enlarged powers is something to be affirmed. Thus, abortion, the relatively new human power to safely and reliably terminate the life of a human fetus without harm to the mother, is defended by the privileged under the newly affirmed moral right to control one's own body.

But the poor most frequently experience power not through its exercise but as the object of its exercise. In such circumstances, the proliferation of new human powers is often threatening. Even where it is not threatening, morally uncharted territory does not carry the presumption of new powers to be exercised, and so promises not liberation but only moral confusion. The import of our current moral crisis for the larger society is as yet ambiguous; for the poor, it connotes advancing moral anarchy and degradation.

Class Isolation

The political life of communities is based on the relationship of human groups, particularly social classes, to one another. The conventional wisdom asserts that technological progress has broken down traditional, hierarchical patterns of political relationships. This argument suggests that scientific and technological developments have freed society from the necessity of the menial, and therefore from the necessity of the slave. As machinery assumes the tasks previously assigned to the slave, the slave is liberated.

There is much truth to this argument, as far as it goes. Patterns of deference and submission among the poor have certainly been diminished. The authority of the elite, once unquestioned, is subject to check and challenge in ways that would astonish our predecessors. The democratization of social and political relationships, especially since World War II, is dramatic and unprecedented.

But this erosion of hierarchies of class and race has been accompanied by another phenomenon rarely remarked on—one that vitiates much of the recent democratization. For even as old hierarchies have given way, they have been replaced not with a more integrated and democratic class structure but instead with increasing alienation. The same technological forces that have undermined old patterns of deference have also greatly diminished intercourse among the classes.

Intercourse among the classes is not to be confused with social mobility. The movement of members of the younger generation up the class structure does not appear to have much diminished. But members of any given social class have less frequent, less intensive face-to-face interaction with members of different social classes than historically. The result is increased class segregation and isolation.

Interclass communication and social intercourse have traditionally occurred in the workplace, the neighborhood, and the home. Technology has eroded the opportunities for social interaction in all three.

Trouble at Work

The sheer increase in the size of business enterprises, and the resulting bureaucratization, have fostered class segregation in the workplace. Direct communication between owner or manager and shop-floor worker decreases as enterprises grow and hierarchical layers of supervisors are interposed. In most major business enterprises, levels of authority in the organizational chart coincide with the social-class hierarchy in the workplace and the larger world. People at each level, and therefore each social class, deal only with those immediately above and below on the organizational (and social) ladder.

This increasing class segregation may be an important factor in the declining productivity of American industry. Thus, the Japanese and British extremes of high and low productivity may correlate with extremes of class integration and segregation in the workplace. If growing class segregation is an important component of declining productivity, then current elitist patterns of American business education and recruitment will only advance the decline in productivity.

In the neighborhood, the development of immense transportation networks, and the resulting suburbanization, have fostered residential class segregation. While housing patterns have always reflected the human tendency to live in class enclaves, historically those enclaves were smaller and more densely interwoven. The strict and large-scale class differentiation of whole communities, now characteristic of the American city and its surrounding suburbs, was not possible prior to the development of speedy transportation for all.

However unwelcome in earlier times, lower-class providers of essential services to the elite had to live in closer proximity to those whom they served. Today, most of us drive from work to our neighborhoods or suburbs, which house our social peers in similar buildings for block after block, tract after tract. We need never encounter those above or below us on the social scale as we participate in community life.

Finally, the mechanization of domestic work has diminished interclass communication in the home. The "upstairs-downstairs" phenomenon, though nostalgically romanticized, did at least bring members of widely divergent social classes into intimate contact. That phenomenon has almost entirely disappeared in American life.

This intensifying class segregation has been experienced as liberation by the more affluent. The suburbs promise relief from daily confrontation with squalor, or even social difference. The affluent are comforted by having to deal only with the affluent.

The poor, of course, experience class segregation as abandonment and exclusion. While old hierarchies may have given way to apparent democratization, the promised benefits recede with the affluent exodus. The resulting sense of exclusion and isolation causes the political degradation of poor communities.

But the aesthetic, moral, and political degradation caused by technological advance is not confined to the poor. There is evidence throughout our society of ambivalence about the cultural impact of unrestrained technological change. The loss of an older, satisfying relationship with humanized, beloved things; the moral confusion attendant on the proliferation of new, technologically induced human powers; the loss of interdependent relationships with others different from ourselves—all these things trouble us, even in the midst of our technological abundance and power.

The poor, rather than tagging along behind the rest of us in the process of technological transformation, may be our precursors in a degradation soon to be experienced by all. We should recognize in the accelerating collapse of community among the poor a reproach and a warning. A reproach in that we tolerate such misery in our midst; and a warning in that it is, and will be, our shared degradation, unless we examine and comprehend the contradictions inherent in technological advance. We fail ourselves and our future by failing to confront them. □

Lewis H. Spence is court-appointed receiver (administrator) of the Boston Housing Authority and a graduate of Harvard Law School. This article is condensed from remarks made at a symposium entitled "Science, Technology, and Everyman's Life" at M.I.T. in December 1981.

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Unsnarling Signals in Space

by Tom Logsdon

WHILE you are reading these words, 50,000 telephone calls are streaming toward communications satellites for retransmission back to earth. So are dozens of color television shows. Computer data, video conferences, religious fund raisers, stock-market quotes—all depend on satellite transmissions. In addition, approximately 70 percent of America's long-distance military communications are routed through outer space. Circuit revenues currently exceed $1 billion per year, and, according to projections by Intelsat Corp.'s Joseph Pelton, "By the 1990's, satellite communications could be a $10 billion business."

Almost all modern communications satellites are launched into "geosynchronous" orbits 22,300 miles above the equator, an altitude at which they remain motionless as seen from the spinning earth. Unfortunately, we are beginning to encounter serious traffic jams along the geosynchronous arc. Physical crowding is not the issue: there is ample space for the few dozen satellites currently sprinkled along a circle 165,000 miles long. The main problem is that a ground antenna typically sends out a beam that spans several degrees by the time it reaches the geosynchronous altitude. Hence, if we position our communications satellites too closely together, messages directed toward one can spill over onto its neighbors in space. Interference can also occur among signals returning to earth.

Current practice calls for 4-degree spacings between adjacent satellites, but if existing growth rates are maintained, this will soon be impossible. Today at least 70 satellites are hovering along the geosynchronous arc. And according to estimates by expert Walter L. Morgan, formerly of Communications Satellite Corp., the number of messages being relayed through U.S. domestic satellites is doubling every three years.

Of course, there are ways to squeeze more satellites into space and rig future satellites to handle heavier volumes of traffic. Unfortunately, each approach has its own disadvantages.

The cheapest and simplest solution to orbital overcrowding may be to develop ground antennas with sufficient directionality and discrimination to handle signals from satellites spaced closer together. Recent studies by the Federal Communications Commission (FCC) indicate that satellites using conventional transmission frequencies could be placed 3 degrees or even 2 degrees apart, thus increasing the number of orbital slots by 50 to 100 percent. But this is, at best, a stopgap measure. The FCC says that even if all geosynchronous satellites are moved to within 3 degrees of one another, "Only about three or four orbital locations would be unassigned after the remaining requests filed before May 1, 1980, are honored."

Moreover, if satellites are bunched closer together, hundreds of users will be required to buy and install more expensive antennas. Specifically, they might have to adopt antennas with special feeds that block off a smaller portion of the signal hitting the receiving dish. Unfortunately, a 25-foot antenna of this type costs about $130,000, about twice the cost of an antenna with conventional mountings.

More Frequencies

All modern communications satellites are "repeaters"—they pick up faint messages from the ground, amplify them electronically, and retransmit them on a different frequency. A frequency in the vicinity of 6 gigahertz (6 billion oscillations per second) is commonly used for transmissions up to the satellites, with a 4-gigahertz frequency used for downward transmissions. The corresponding radio waves are about two and three inches long, respectively.

Most of the frequencies near 6 and 4 gigahertz that are set aside for satellite communications are already in use, and those nearby are devoted to other services such as radioastronomy and navigation radar. The use of additional frequencies would allow extra messages to be relayed through space. And if higher frequencies were also used, satellites could be spaced closer together, because an antenna sends out a thinner beam if it is transmitting at a higher frequency.

Some communications satellites are already using 11-gigahertz uplinks and 14-gigahertz downlinks, and tests are being conducted in the vicinity of 30 gigahertz. The latter would make possible satellite spacings as close as 1 degree. However, use of these higher frequencies would require new ground antennas and much larger and more expensive satellite antennas.

Another difficulty is that falling raindrops tend to absorb higher-frequency radio waves. Possible solutions include spacing pairs of ground antennas several miles apart so that at least one is likely to lie outside a heavy rainstorm. Another possibility is mounting 30-gigahertz antennas on tethered, superpressure balloons. Optical fibers running the length of the tether would carry clear signals up and down through the rain.

Reuse of Frequencies

Although hundreds of VHF television stations are operating in the United States, they share only twelve different transmission frequencies. Channels 2 through 13 can be reused in various cities because television waves literally do not reach beyond the horizon. Satellite frequencies can also be reused if the coverage areas do not overlap. Even overlapping areas can be served twice by the same frequency if the signals are polarized. A radio signal can be polarized by transmitting it through parallel louvers resembling Venetian blinds. Designers rigged the newly designed *Intelsat V* communications satellite for multiple-frequency reuse by equipping it with pairs of polarized antennas pointing in opposite directions.

We can achieve much more complete reuse of frequencies with "multibeam" satellite antennas. These transmit a family of pencil-thin beams often so narrow that by the time they reach the ground, their "footprint" covers an oval only a few dozen miles wide. As a result, the same frequencies are available for multiple reuse in widely scattered areas.

Multibeam antennas are larger, heavier, more complicated, and more costly than their simpler counterparts, but their extra capabilities will become increasingly attractive as available frequencies are expended. Some military satellites already employ multibeam antennas, and, when the space shuttle is available for delivering large structures into space, they will be widely adopted for civilian applications.

Multifunction Platforms

Another way to control traffic at the geosynchronous altitude is to install a few large multifunction platforms for communications relays. Such platforms would be equipped with several antennas, each operating on a different frequency and devoted

(Continued on page 86)

Tom Logsdon, an aerospace engineer at Rockwell International, is currently working on the Navstar navigation satellite. His latest book is How to Cope with Computers *(Hayden Book Co., 1982).*

Intelsat V communications satellite. Antennas on this satellite polarize signals into horizontal and vertical components, allowing the same frequency to be used twice. These large antennas direct pencil-thin beams to specific sectors on the earth, allowing the same frequency to carry different messages to each location. The *Intelsat V* was the first nonexperimental satellite using the 14/11-gigahertz frequency, a band that remains relatively uncrowded at the geosynchronous arc compared with the more popular 4/6 gigahertz frequency. The Etam earth station (inset) in Etam, West Virginia, the world's busiest station for commercial communications satellites, added a 60-foot dish antenna in 1981 to receive the 14/11 gigahertz frequency transmitted from the *Intelsat V* series. (Photos: COMSAT)

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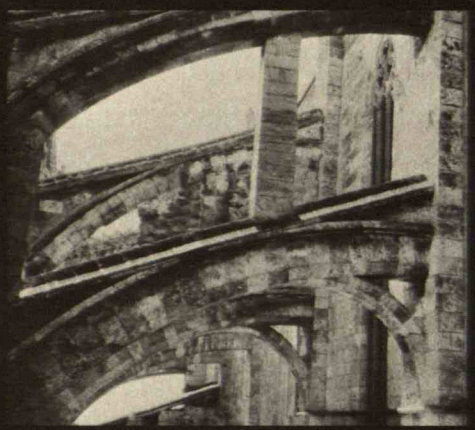
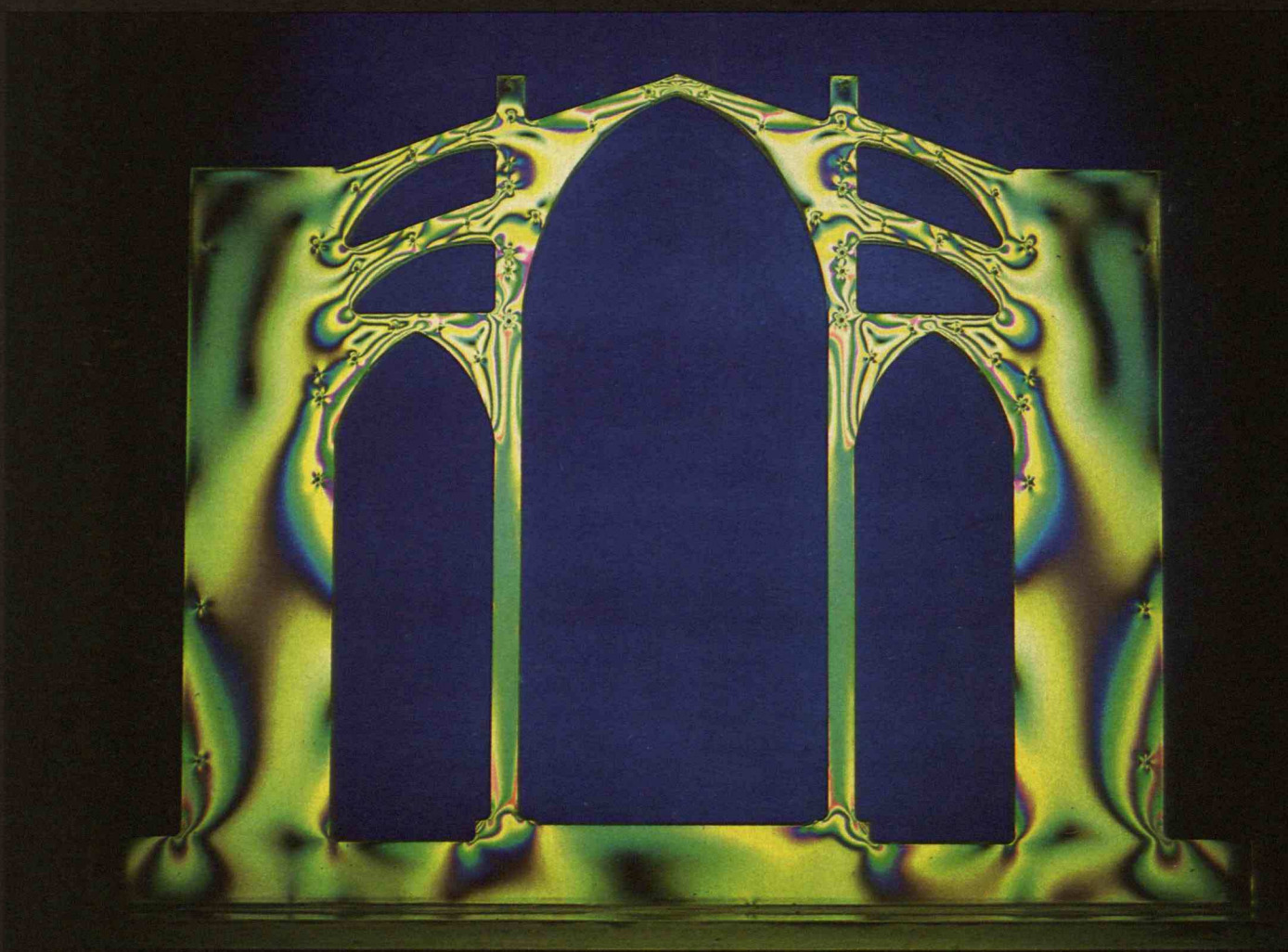
Technologies

A contour map of strain (bottom)
revealed by polarizing light in a plastic model of the cathedral at
Palma, Majorca (below). Dense patterning in the flying buttresses indicates stress,
whereas areas of uniform color are relatively
stress-free.

This "photoelastic interference"
technique helped determine that the buttressses were probably
the cause of some structural stress, and
additional arches now
support them.





PHOTOS: FROM *EXPERIMENTS IN GOTHIC STRUCTURE* BY ROBERT MARKS

When Cracks Become Breakthroughs

Structural failure, not success, improves the evolution of a design.

by Henry Petroski

ENGINEERING, like other human endeavors, advances through mistakes, and the bigger the consequences of the mistake, the more emphatic and long-lasting the lesson. The dramatic collapse of a great bridge, showering tons of concrete and steel into a space it once so gracefully spanned, symbolizes the ever-present, albeit small, risk of structural failure. Yet no matter how spectacular or symbolic any one failure may be, each structure tends to have design characteristics that distinguish it both from its predecessors and successors.

The Tacoma Narrows bridge, one of the most awesome and familiar failures in engineering history, was a departure in design from its predecessors. When completed in 1940, it was not only one of the longest spans for a suspension bridge, it was to use a radically new deck structure that would give it a more graceful silhouette. Unfortunately, the slenderness of its profile also made the bridge aerodynamically unstable. It twisted itself apart in a high wind, a dramatic event recorded for posterity by newsreel cameras.

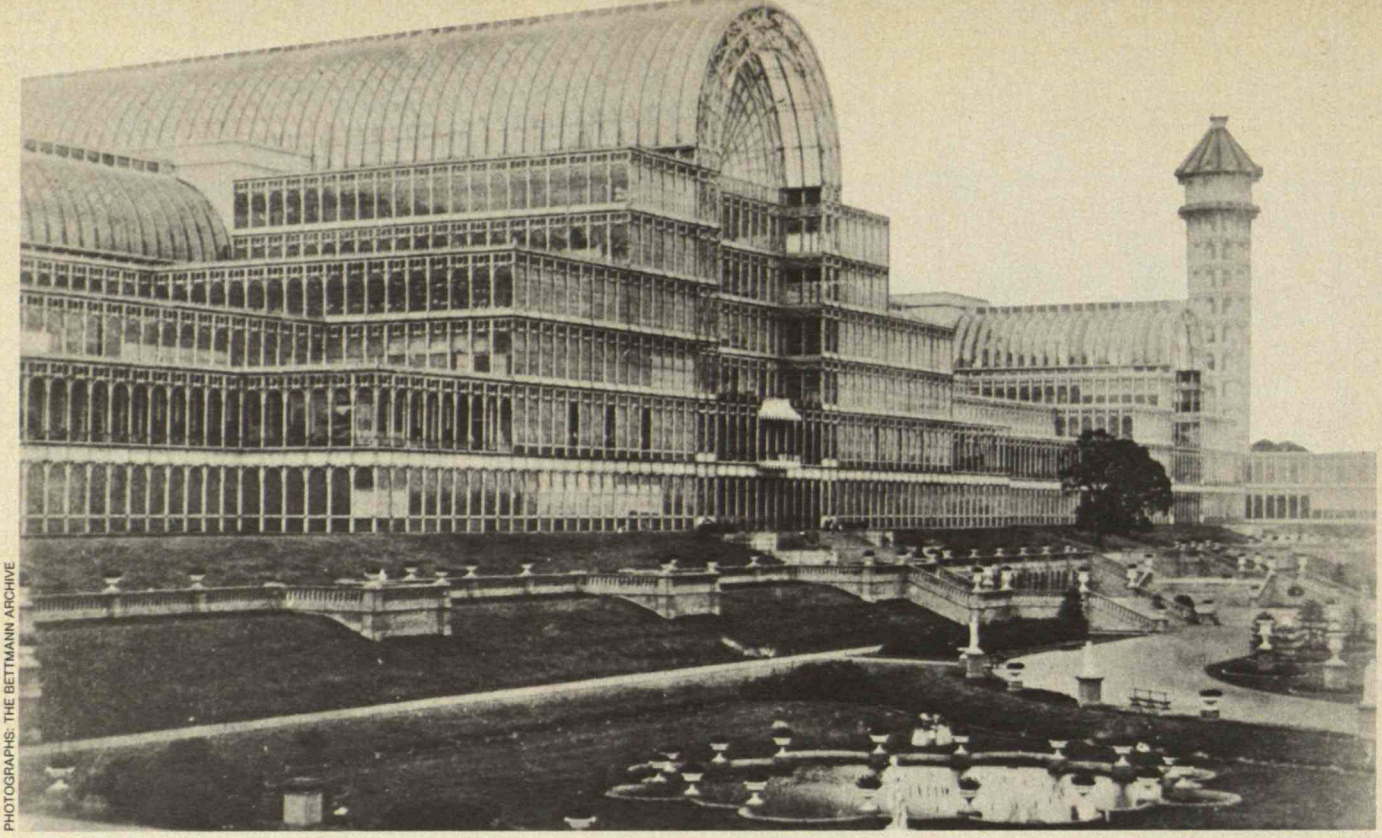
The Bronx Whitestone bridge in New York City was designed along similar lines, but it was quickly retrofitted with extra steel along its sides to stiffen the roadway against high winds. To this day, the undulations of the bridge are distracting to motorists; it is only now being fitted with mechanical devices to reduce the aerodynamic motion that has persisted for almost 40 years. Yet the bridge stands as an example of the small details that can make the difference between success and failure.

The elevated walkways that collapsed into the crowded lobby of the Hyatt Regency Hotel in Kansas City last year were also a kind of bridge. Such skywalks were not explicitly covered by the Kansas City building code, and engineers had to combine recommendations for similar structures that *were* covered. The unorthodox original design, apparently not easily translated into reality at the construction site, spawned changes in structural details that were ad hoc, unsophisticated, and tragically inadequate. However, a recent report from the National Bureau of Standards claims that the original design was inadequate for the loads the walkways were to endure, so that on-site changes "aggravated an already critical situation."

The Plague of Fatigue

For all the popular coverage, each dramatic structural failure such as the Tacoma Narrows bridge, the Hyatt Regency walkways, and the DC-10 crash in Chicago has its own anomalous characteristics—no one incident is "representative" of structural engineering failures.

However, one category of failure has been a chronic problem for centuries. It is "brittle fracture," in which a large crack runs spontaneously through a structure near the speed of sound, severing steel with a report that signals the breakup of ships, the bursting of pressure vessels, or the collapse of bridges. There is almost always a period of "gestation"—the virtually undetectable slow lengthening and sharpening of cracks that precedes the catastrophe. (While the Chicago DC-10 failed because of just such a large crack, abusive maintenance procedures altered its gestation



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period, putting the crash in its own category.)

In the early years of rail transportation in England, the new iron horses suffered so many accidents from breaking axles and collapsing iron bridges that Queen Victoria appointed a special commission to look into the matter. The mysterious source of these failures—metal fatigue—to this day causes an estimated 50 to 90 percent of generally undramatic mechanical and structural failures. Almost all go unreported save in engineering trade journals, yet the failures often induce massive product recalls, colossal inconvenience, and great cost that can make companies themselves fail. Sometimes these failures are dramatic and fatal, as when a steel bridge that had spanned the Ohio River near Point Pleasant, W.Va. for decades collapsed in 1967 and left 46 persons dead.

Such incidents are variations on the structural and mechanical engineer's most persistent generic design problem. The weakening of metal structures owing to intermittment loading, whether traffic on a bridge, turbulence on an airplane wing, or the sea on an offshore oil platform, remains the most studied and least understood phenomenon of materials science a century and a half after it was formally recognized by French engineer Jean-Victor Poncelet. (He is believed to have coined the term "fatigue" in his *Mécanique Industrielle* in 1839.)

Today metal fatigue plagues the transportation industry and hinders the development of new designs. For example, the de Havilland Comet airplane was to be the first passenger jet aircraft to exploit the experience gained from using fighter jets during World War II. The British company gained an early competitive edge worldwide with its daring leap into production of an airplane that would carry more passengers and fly faster, higher, and more economically than any other craft. The planes flew admirably through years of test flights, but after a year of commercial service they began exploding mysteriously in mid-air. Only after three Comets failed in this way were an unprecedented series of full-scale engineering tests performed. These revealed that metal fatigue, against which designers were sure they had taken every precaution, was the culprit.

More than a quarter of a century later, even after we have sent astronauts to the moon and brought them back, demonstrating that unique and untested engineering systems can be reliably designed, the mundane problem of metal fatigue still plagued new lightweight city buses. The Grumman Corp.'s "Flxibles" (the name derives from the company's flexible couplers that connected sidecars to motorcycles during World War I) were ordered by the hundreds for large cities such as New York and Atlanta. The profits from the Flxible bus division were to keep the Grumman Corp. financially healthy during the lean years of the cutbacks in defense spending, upon which the company's other divisions depended.

However, in 1980 New York withdrew its entire fleet of 637 Flxibles from their relatively brief service because so many fatigue cracks had developed in the lightweight frames. The last of the buses returned to service a year later, after the flawed design had been beefed up, inelegantly and at considerable cost to the company, both for retrofitting and in lost future sales. In fact, the Flxible brought so much opprobrium to

The interior and exterior Crystal Palace, built in London to house the Great Exhibition of 1851 and tested for safety before Queen Victoria and her entourage. A group of workers assembled a section of gallery floor and crowded onto it. They walked across it first in regular step, then in irregular step, and finally jumped up and down in unison, to prove to the queen that the platforms were sound.

Grumman that the company changed the name of the bus to "Metro." But that could not prevent the bus subsidiary from losing $30.8 million, the principal cause of the Grumman Corp.'s 73.5 percent drop in last year's fourth-quarter profits.

How could de Havilland and Grumman engineers have been so far off the mark, and why didn't they produce more conservative designs? These questions pertain not only to the difficulty of predicting structural behavior under complex and uncertain loading patterns, but also to how often engineers must fit their knowledge to economic as well as scientific constraints.

Limits of the Laboratory

Queen Victoria's committee reiterated the contemporary thinking that vibrations in metal somehow transformed iron from a tough, fibrous material to a more fragile, crystalline one. This erroneous theory, based on the characteristically brittle appearance of the surface of a part broken by progressive fatigue, remained current well into the middle of this century.

Today there are several metallurgical theories to explain the mechanism of progressive fatigue damage, including elaborate hypothesized dislocations in the metal microstructure, but none is wholly satisfying. Yet even as metallurgists debate the microscopic details of exactly how a piece of metal breaks, engineers are constantly being called upon to design machines and structures that will be subjected to violent extremes of vibrations and other varying loads. Thus, engineers must develop practical methods for predicting the lifetimes of these structures.

If we consider that our understanding of the process itself is incomplete, the success of engineers in designing against fatigue seems admirable. For several decades they have viewed the fatigue process as consisting of essentially two stages. Microscopic cracks develop at "nucleation sites"—points of material weakness or stress concentration—during the first stage, which may occupy as much as one-half of the entire lifetime of a machine part or structure. As repeated loading continues, these cracks grow and some coalesce into a dominant macroscopic fatigue crack. During the second stage, this crack grows at an accelerating rate as the cycles of loading continue. If the crack reaches an intolerable size for the load being applied, the weakened structure can no longer support it. The crack makes a final fast advance under a load level that may be well within the design load of the (unfatigued) structure.

Metallurgists have learned, often empirically, to produce alloy metals with as few nucleation sites and as much resistance to crack growth as possible. And engineers have learned to beef up joints to reduce localized load levels and to use materials with large capacities for containing cracks without suffering brittle fracture. But the problem of metal fatigue persists because both metallurgist and engineer attempt to predict, from limited past experience, the behavior of materials in an uncertain future environment of use and abuse. The slightest deviation from experience in a new design can have unanticipated consequences.

Moreover, understanding the phenomenon of fatigue and preventing it are two entirely different

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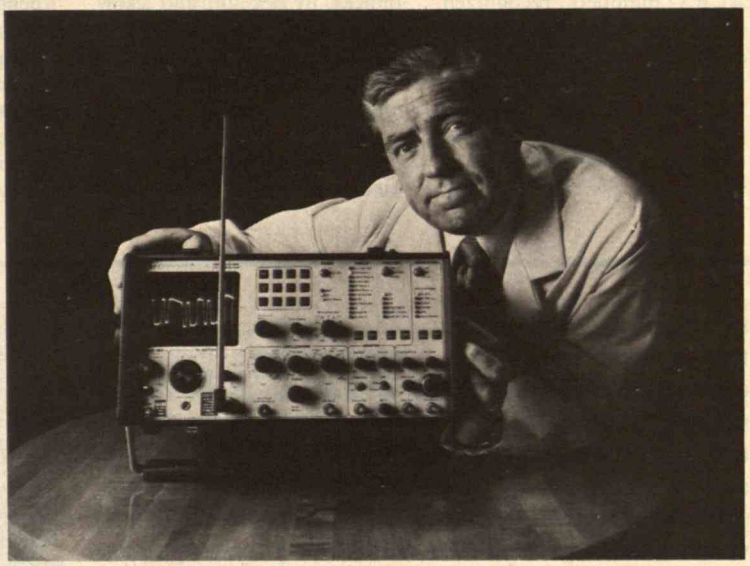

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Reactor Vessels: Safety as a Moving Target

THE issue of whether cracks were growing to dangerous sizes in the walls of reactor vessels was hotly debated during the mid-1960s among members of the nuclear industry, the Atomic Energy Commission, and that agency's Advisory Committee on Reactor Safeguards. ACRS members recognized that it was impossible to guarantee that steel reactor vessels with six- to eight-inch-thick walls were flawless. Because fabrication and inspection techniques were less than perfect, one simply had to assume that defects of minimum sizes existed.

Furthermore, over the decades during which nuclear plants were expected to operate, cycles of heating and cooling, fluctuations in power and pressure levels, and general variations in the stresses in the vessel wall could cause fatigue cracks to develop and grow. Whether these cracks would be detected was uncertain, given the difficulties of inspecting nuclear plants while in operation. Therefore, certain types of cracks had to be assumed to exist, even though analysis of fracture mechanics could reasonably demonstrate they were generally benign.

But the issue was complicated by the fact that the steels from which reactor pressure vessels are made do not have a single "fracture toughness"—their resistance to catastrophic fracture depends upon the temperature of the metal. There is a certain temperature below which the material is very brittle and not tough at all, called the "reference temperature" when it incorporates a safety margin.

As long as a reactor vessel is pressurized well above this temperature, there is no danger of any crack opening catastrophically. But when steel is cooled below the reference temperature, brittle fracture can occur. This phenomenon was partly responsible for the sudden collapse in winter of some early welded bridge designs and for the spectacular breakup of Liberty ships during World War II.

Nuclear reactor vessels are designed to operate well above the reference temperature of their steels. Unfortunately, one of the effects of neutron

things. Hypotheses are tested under the ideal, controlled conditions of the laboratory. Test specimens can be carefully machined to provide as flawless a surface as possible, and loading conditions can be carefully specified and monitored. Since replication of test results is achievable under such conditions, smooth curves of repeated load levels or stress (S) versus number of cycles to failure (N) by fatigue are easily generated. These "S-N" curves characterize the behavior of each type of material. Of course, as the stress is diminished, the number of cycles to failure—the structure's "lifetime"—increases. Furthermore, if the load level is diminished below a threshold value, failure is never observed no matter how many cycles of loading are applied.

Fatigue can thus be theoretically avoided, but overdesigning structures so that peak stresses never exceed the threshold level is not practical. An airplane designed that way might be too heavy to fly. And even if it could, a competing manufacturer would soon produce a lighter design that was less expensive to build, buy, and operate. Yet "optimal" design, in which fatigue-crack propagation is acknowledged to occur but so slowly that the structure will have long been taken out of service before the crack poses any safety problem, is also more easily conceived in principle than achieved in practice.

Although the simple S-N curve is readily available for engineering materials, its use in design is not so straightforward. For one thing, the curves must be interpreted statistically, with ranges of uncertainty being more important than points on smooth curves. Not only will there be scatter in the collection of fatigue data, there is variation among batches of the same material and parts of the same batch used in different physical and chemical environments.

Furthermore, fabricated structures are not nearly so flawless and free of crack nucleation sites as their laboratory models. Carelessness such as that which leads to faulty welding can not only introduce important nucleation sites but also can provide massive fissures in the metal that bypass the crack nucleation phase altogether. The fabrication stage also introduces residual stresses in the structure, and these can be the principal driving forces of the early stages of the fatigue process.

Finally, the actual loadings to which engineering structures are subjected are not nearly as regular or mathematically precise as test loads employed under laboratory conditions, and sometimes the actual conditions are not even taken into account by the designer. This was the case with the DC-10 engine mount, in which large cracks were introduced through severe and unanticipated maintenance procedures.

Testing for Cracks

"Quality control" is supposed to eliminate unacceptably large flaws by minimizing deviations from an acceptable norm and by rejecting inferior workmanship. But unfortunately, the techniques for detection of preexisting cracks in fabricated structures are wanting. Not only are instruments relatively insensitive, but their use and interpretation are often more art than science.

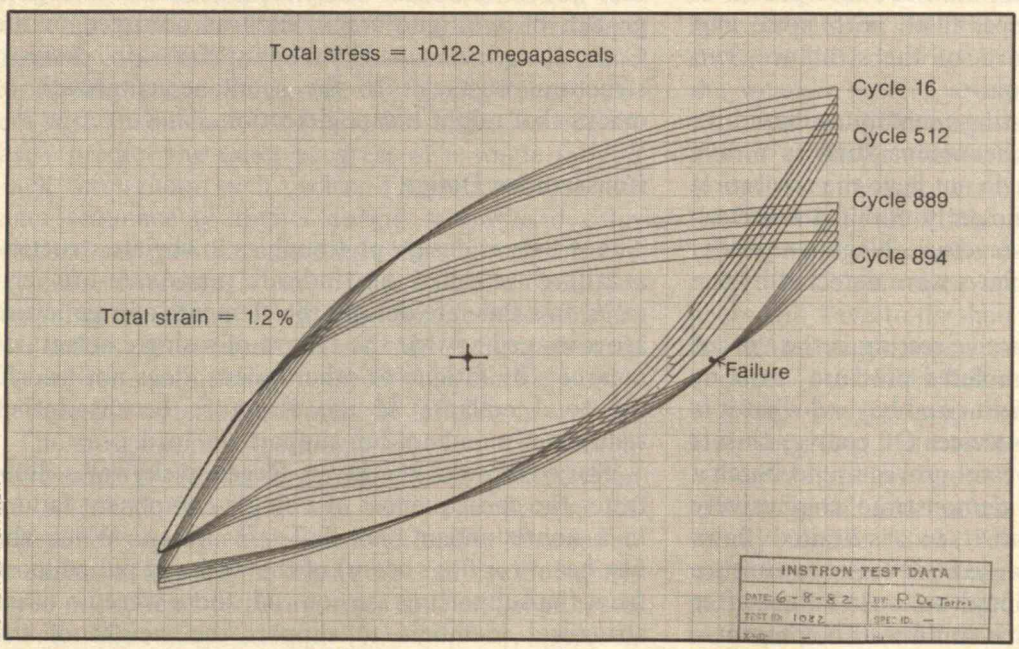
One of the most promising tools of "nondestructive

irradiation from the reactor's core is to raise the reference temperature over a plant's lifetime. This fact was known in the mid-1960s, but there was no experience to indicate exactly how high the critical temperature of today's reactors would be raised. Engineers and metallurgists made what they considered conservative projections of the damaging effects of the neutron flux and designed their reactors accordingly.

Now, 15 years later, only about halfway through the lifetime of most early reactors, tests on irradiated steel are suggesting that embrittling progresses much faster than anticipated. When first installed, these reactors could be operated at temperatures as low as 100°F and still remain on the upper shelf of fracture toughness. Now, some reference temperatures are estimated to be in excess of 200°F. Although reactors normally operate at about 600°F, the perilous combination of a lower temperature and a high pressure cannot be completely ruled out. Should an accident occur that would trigger the emergency core cooling systems to cool the pressurized reactor vessel too quickly—toward a raised reference temperature—any preexisting cracks could grow quite rapidly.

Reactor operators, who closely monitor the fracture toughness of their vessels, do not generally believe that embrittlement has progressed to dangerous levels, and steadily improving techniques for detecting cracks make the operators confident that they are taking no unnecessary risks. Furthermore, reactor operators expect that annealing techniques now being developed that can soften and toughen steel will enable them to lower the reference temperature, thus reversing the embrittling effects of neutron irradiation and restoring the safety margin to earlier levels.—*H.P.* □

Before a catastrophe there is almost always a period of "gestation"—the virtually undetectable slow lengthening and sharpening of cracks. In the case of the Chicago DC-10 crash (left), abusive maintenance procedures exacerbated this process.



The results of a cyclical fatigue test of an aluminum sample, in which the sample failed on the 895th cycle. Engineers can use this test to derive an "S-N curve," which shows the amount of stress at different loading cycles for the materials. These tests were made using the Instron Model 8000 servohydraulic system. (Stress is measured in pascals—a unit of pressure defined as newtons per square meter.)

Fatigue Is Child's Play

MANY of the small annoyances of daily life are due to fractures from repeated use. Shoelaces and light bulbs, as well as many other familiar objects, suddenly fail under conditions no more severe than they had been subjected to hundreds or thousands of times before.

A bulb that has burned continuously for decades may appear in a book of world records, but to an engineer versed in fatigue, the performance is not remarkable. Only if the bulb has been turned on and off daily all those years would its endurance be extraordinary, for it is the cyclic and not the continuous heating of the filament that is its undoing. Thus, because of the fatiguing effect of being constantly changed, it is the rare scoreboard that does not have at least one bulb blown.

Children's toys are especially prone to fatigue failure, not only because children subject them to seemingly endless cycles of use, but also because the toys are not generally overdesigned. Building a toy too ruggedly could make it too heavy for the child to manipulate, not to mention more expensive than its imitators. Thus, the seams of rubber balls crack open after so many bounces, the joints of plastic tricycles break after so many trips around the block, and the heads of plastic dolls separate after so many nods of agreement.

One of the most innovative electronic toys of recent years has been the victim of mechanical fatigue long before children (and their parents) tired of playing with it. Speak & Spell effectively employs one of the first microelectronic voice synthesizers. The bright plastic toy asks the child in a now-familiar voice to spell a vocabulary of words from the toy's memory. The child pecks out letters on the keyboard, and they appear on a calculator-like display. When the child finishes spelling the word, he or she presses the ENTER key and the computer toy says whether the spelling is correct and whether the child should try again. Speak & Spell is so sophisticated that it will turn itself off if the child does not press a button for five minutes or so, thus conserving its four C-cell batteries.

My son's Speak & Spell had given him hundreds of

testing"—the collective term for techniques used to probe for flaws within opaque parts and the welds that join them—employs ultrasonic waves. By sending these waves into a part and observing their return, the internal integrity of the otherwise opaque product can be determined without the structure or part being destroyed in the process. A fissure, void, foreign body, or other potentially troublesome flaw in the metal will reflect ultrasonic waves in a characteristic way to a receiving transducer. Unfortunately, the mathematical characteristics of reflected waves are unknown for most of the complex geometries that comprise modern structures. And the interpretation of signals on an oscilloscope, filled with noise and interference from other parts of the structure, can leave a lot to the imagination.

Other nondestructive testing techniques, based on well-understood physical phenomena such as x-rays and magnetic fields, simply do not have the resolution and sensitivity to give sufficiently detailed information about an engineering structure. Negative results simply mean that no *large* flaws were detected by the equipment and operators.

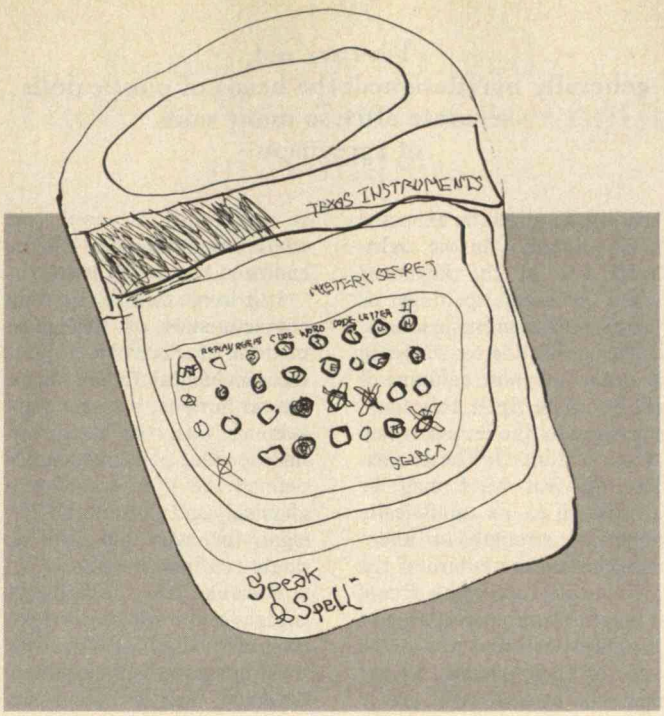
A variation on nondestructive testing is the "proof test," in which a newly completed pressure vessel or other container is slowly pressurized beyond what it is expected to withstand in service. Of course, this is nondestructive only if the vessel proves sound. Such a technique would seem to demonstrate conclusively the integrity of the part, but it, too, is limited: flaws small enough not to have caused the vessel to rupture during the test but large enough to cause failure after a significant period of service could well be present.

The existence of undetected small flaws can be hypothesized from the observed strength of the structure or inferred from the sensitivity of the testing technique. Engineers must assume that such cracks exist and calculate their rate of growth. For example, when an airplane is constructed, quality-control procedures and proof tests in the form of test flights ensure that no dangerously large cracks exist in the structural members. Yet initially benign cracks may indeed exist, and engineers determine how long it should take such cracks to reach detectable size and thus how often inspections should be made. For further protection from catastrophic failure owing to growth of a fatigue crack, such as occurred in the Comets, engineers usually employ "fail-safe" designs: structural obstacles to the spontaneous growth of cracks that might escape detection.

Conservative Design

The two basic design philosophies to obviate structural failure are called the "fail-safe" and "safe-life" criteria. In a fail-safe design, the elements of a structure are arranged so that the failure of a single structural member, by fatigue or other means, does not lead to the total collapse of the structure because other redundant members can support the load.

The collapse of the Hyatt Regency skywalks illustrates the consequences of a single component failure in a nonredundant, non-fail-safe design. When the box beam (or floor beam) of the walkway pulled loose from the supporting tension rod, there were no other structural members to support the weight of the



The limiting characteristic of an electronic teaching toy—the mechanical failure of its buttons—educates the child in a way unforeseen by the manufacturer.

hours of enjoyment when one day the ENTER key broke off at its plastic hinge. But since Stephen could still fit his finger into the buttonhole to activate the switch, he continued to enjoy the smart, if disfigured, toy. Soon thereafter, however, the *E* key snapped off, and soon the *T* and *O* keys followed suit. Although he still uses the toy, its keyboard is a maze of missing letters and, for those that were saved from the vacuum cleaner, taped-on buttons.

What makes these failures so interesting is the very strong correlation between the most frequently occurring letters in the English language and the fatigued keys on Stephen's Speak & Spell. It is not surprising that the ENTER key is broken, since it was employed for inputting each word. Of the seven most common letters—in decreasing occurrence:

unsupported portion of the walkway. Since all other beams presumably were marginally designed as well, the initiating event overloaded them and touched off an irreversible sequence of failures. (After the accident, the remaining skywalk was removed and a new elevated walkway supported by columns in compression rather than rods in tension was erected.)

Safe-life design, which allows for the inevitability of failure well beyond the service life of the structure, is not so simple to realize. The engineer can ascertain, relatively easily, what might be the worst initial flaw in a structure, but specification of exactly how the structure will subsequently be loaded, and how the crack may grow, is not possible. For example, a design engineer can estimate the routine loads on an airplane during its lifetime of takeoffs, climbs, flights, encounters with turbulence, landings, and taxis, but cannot easily predict the exact progress of a single fatigue crack throughout such cycles. That depends on the exact sequence of flights during storms and calm weather, soft and hard landings, and light and heavy payloads. Moreover, the mathematical models for analyzing the effects of different load levels in different orders of occurrence are far from standard. Therefore, a safe design must not rely entirely upon the safe-life criterion but must be fail-safe as well.

The most common technique for computing cumulative crack growth under variable loads is based upon the so-called linear damage rule: the fraction of fatigue life consumed at each load level is assumed to be equal to the ratio of the number of cycles experienced at the level to the number of cycles that *could* be endured at that load level. This simplistic approach has many shortcomings, principally its inability to account for the order in which different load levels are applied. For example, materials respond differently when a period of high load follows one of low load than when the opposite occurs.

More sophisticated (nonlinear) damage rules have been proposed to improve on the linear rule, but none has gained universal acceptance. These require more effort to apply, and their predictions are as scattered as those of the much simpler linear rule. Furthermore, the results of any systematic rule can be only as good as the inputs to the calculations. No equation can ensure that the traffic on a bridge will follow an historic pattern, that the maintenance of an airplane engine will be done according to specification, or that the weather pattern around an offshore oil platform will hold to the designer's predictions. Thus, the limitations of "deterministic" models have led to the use of statistical techniques, especially in situations where the loading is essentially random.

Despite the limitations of analysis, whether from inadequate theories or uncertain input, design engineers still have to do their jobs. And since real-time, full-scale fatigue experiments are generally out of the question—to build a full-size model of the structure is to build the structure itself—engineers incorporate fault-forgiving features into their designs.

For example, a nuclear power plant must have an extremely reliable system of large-capacity pipes to supply coolant to the reactor core. A sudden large rupture in one of the main supply pipes could lead to a major loss-of-coolant accident. Since cracks in pipes may not be detected during inspections or tests, and

Toys are not generally overdesigned: the heads of plastic dolls separate after so many nods of agreement.

E,T,A,O,I,N,S,R—five, *E,T,O,S,* and *R,* are also broken. All other letter keys, save for the two seemingly anomalous failures of *P* and *Y,* are intact.

This is a striking example of the fatigue phenomenon—an accidental experiment. One must assume that all the letter keys were manufactured equally well. Therefore, those that failed must generally have been the ones pressed most frequently. The correlation between letter frequency and failure substantiates that this did indeed occur.

Because my son is right-handed, he might be expected to favor letters on the right-hand side of the keyboard when guessing spellings or just playing at pressing letters. Since no failed letter occurs in the four left-most columns of the Speak & Spell, this could explain why the letters *A* and *N* are still intact. The anomalous survival of *I* may be attributed to its statistically abnormal strength or underuse, just as the failure of the infrequently occurring *P* and *Y* might be a manifestation of the statistical weakness of the keys or their overuse by my son, who learned early that *Y* is sometimes a vowel and whose surname and cat's name endeared him to the letter *P.*

It is ironic that the limiting characteristics of this most modern of electronic toys is the mechanical failure of its plastic buttons, but that is in keeping with the nature of fatigue. This phenomenon has defined the lifetimes of mechanical and structural designs for ages and will no doubt continue to do so.

Because the failure of bridges and airplanes can endanger hundreds of lives, they must be more than adequately designed. But the failure of a toy, though it may cause tears, is but a lesson for a child's future of broken shoelaces and burnt-out light bulbs.—*H.P.*

Postscript: Since I wrote this report, two new developments have occurred. First, another key has fatigued on Stephen's Speak & Spell—the vowel U, *which occupies a favored position at the lower left of the keyboard. Second, my daughter Karen has informed me that Speak & Spell now has a new style keyboard that does not have individually hinged plastic keys and (presumably) does not suffer from fatigue.*

crack propagation by fatigue cannot be entirely ruled out, reactor designers have devised a safety concept known as the "leak-before-break" criterion. If a certain type of steel is used for the pipe wall, any crack that develops will grow faster through the wall of the pipe than in any other direction. This ensures that a crack will give rise to a small but detectable leak well before a dangerously long crack could develop parallel to a weld seam, leading to a sudden catastrophic rupture of the pipe.

The consequences of structural failure in nuclear plants are so great that extraordinary redundancy and large safety margins are incorporated into the designs. At the other extreme, light-bulb filaments often fail by fatigue, but the frequency is accepted as a reasonable trade-off for a cheap light bulb. For most "in-between" parts or structures, the choices aren't so obvious. No designer wants his or her structure to fail, and no structure is deliberately underdesigned when safety is an issue. Yet designer, client, and user must inevitably confront the unpleasant questions of "how much redundancy is enough?" and "how much cost is too great?"

When a seemingly common structure such as a bus frame is required to support a new lightweight, energy-saving vehicle, or an elevated walkway is specified to span an architectural space without obtrusive columns, designers confidently accept the challenge. They know that engineers' experience with virtually indestructable traditional bus frames and bridges spanning a mile make the achievement well within their capabilities. And new and sophisticated analytical techniques, modern high-strength materials, and the aid of computers provide even greater confidence. But these advances also make engineers overconfident that they can depart dramatically, and perhaps prematurely, from traditional designs.

Failure analysis—the discipline that seeks to reassemble the whole into something greater than the sum of its broken parts—provides the engineer with caveats for future designs. Ironically, structural failure and not success improves the safety of later generations of a design. It is difficult to say whether a century-old bridge was overdesigned or how much lighter the frames of 40-year-old buses could have been. A structural failure, on the other hand, can yield data that tell designers what *not* to do. Had Santayana been an engineer, he might have said, "Those who do not learn from structural failures of the past are condemned to repeat them."

Henry Petroski is associate professor of civil engineering and director of graduate studies in civil and environmental engineering at Duke University. His current research involves the structural dynamics of cracked bodies and fatigue, with applications ranging from nuclear reactor safety and offshore structures to sports equipment and children's toys. Dr. Petroski also writes frequently about technology and society; his essays have appeared in publications such as the *New York Times*, the *Washington Post*, *Science 81*, and *Technology Review*.

Further Reading

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The Kansas City Tragedy: There Is Not Always Strength in Numbers

On Friday evening, July 17, 1981, the lobby of the newest hotel in Kansas City was crowded with people enjoying the big-band sound swinging them into another weekend. Many watched from architecturally graceful walkways suspended across the grand expanse of the atrium. As the party goers tapped their toes and swayed to the strains of "Satin Doll," the walkways themselves gently undulated in time with the music. But the evening was to end with the catastrophic collapse of two of the crowded skywalks onto the floor below.

Over 100 people were killed when the structure failed, and the rest of the world wondered how such a tragedy could have happened. Disputes over responsibility will probably continue for years, but there appears to be clear evidence that the structure was simply not adequately supported.

The original design of the suspension system for the hotel's skywalks worked on paper: the long rods suspended from the ceiling were strong enough, the washers and bolts large enough, and the built-up beams deep enough to support not only the walkways themselves but also the crowds of people that might be expected to assemble upon them. Precisely what "strong enough," "large enough," and "deep enough" meant in terms of structural stresses and strains was a matter of judgment, for the walkways were an architectural concept not explicitly covered in the Kansas City building code. According to the 349-page investigative report on the accident by the National Bureau of Standards (NBS), however, the load capacity of the original connection would still have been only 60 percent of code design requirements for similar structures. Nevertheless, had the walkways been constructed as first designed, they would probably still be functioning today.

Unfortunately, what worked on paper was not easily implemented. The practical difficulties of installing rods four stories high, threaded to receive bolts near their midpoints (where they passed through the upper walkway), prompted changes in the design. Instead of one continuous rod, two separate ones

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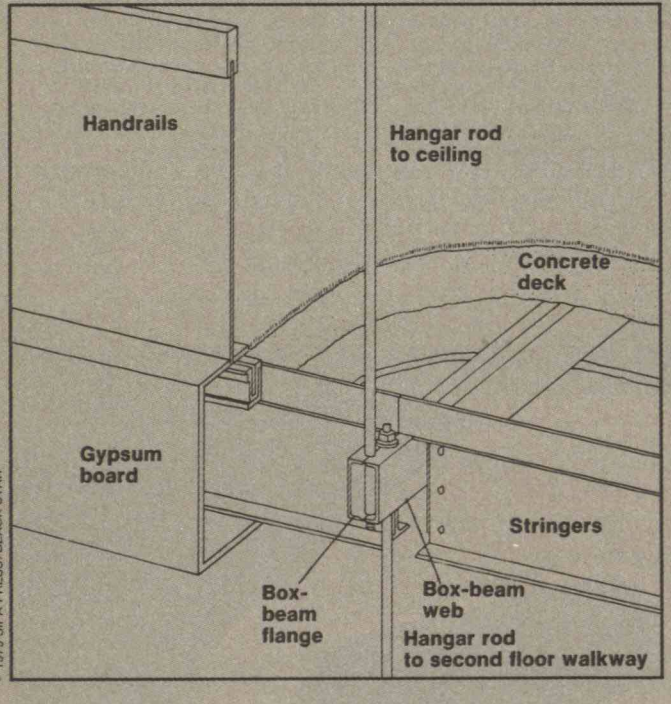
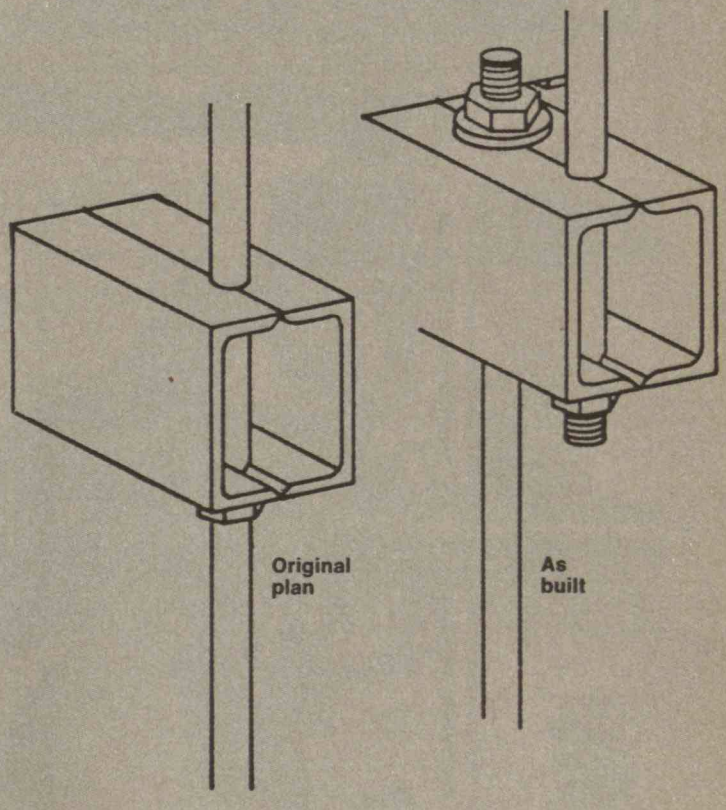


A hanger-rod box-beam connection in the fourth floor Hyatt Regency walkway appears to have been the point of initial failure in the collapse. The box beam, which consists of two steel channels welded together, ran underneath and perpendicular to the concrete deck of the walkway (left). A change in design during the construction of the walkways essentially doubled the stress on the beams. The original plan called for a continuous rod from the ceiling through the walkway beams (below left). Instead, two rods were attached to each beam, one going up and one going down (right).



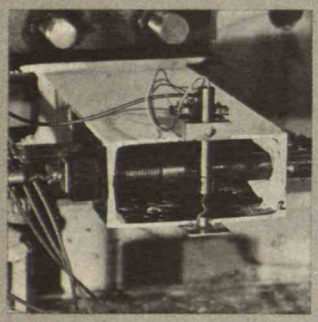
The slightest deviation from experience in a new design can have unanticipated consequences.

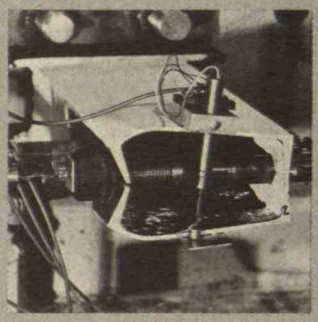
were employed. One support rod extended from the ceiling to the beam of the top walkway, and a second, offset a few inches from the first, extended from the beam to the lower walkway directly beneath. Exactly who suggested the change and how it was approved will likely be the subject of legal proceedings, involving many parties in claims and counterclaims, for years to come; but the incontrovertible fact is that the changed rod configuration effectively doubled the stresses on the beams under the upper walkway. The NBS report estimates that the walkway connection, as installed, could barely support the structure itself, let alone the people assembled on it at the time of collapse.

The mechanics of the problem may be appreciated by considering a simple analogy. Think of the rod as a rope and the two walkways as two people hanging onto the rope. Each person's weight is transferred to the rope through the hands gripping it. The support of the walkways in the original design is analogous to the two people hanging separately, one below the other on the same rope. If the rope and the individuals' grips are strong enough, each person can hold onto a separate section of the rope without falling.

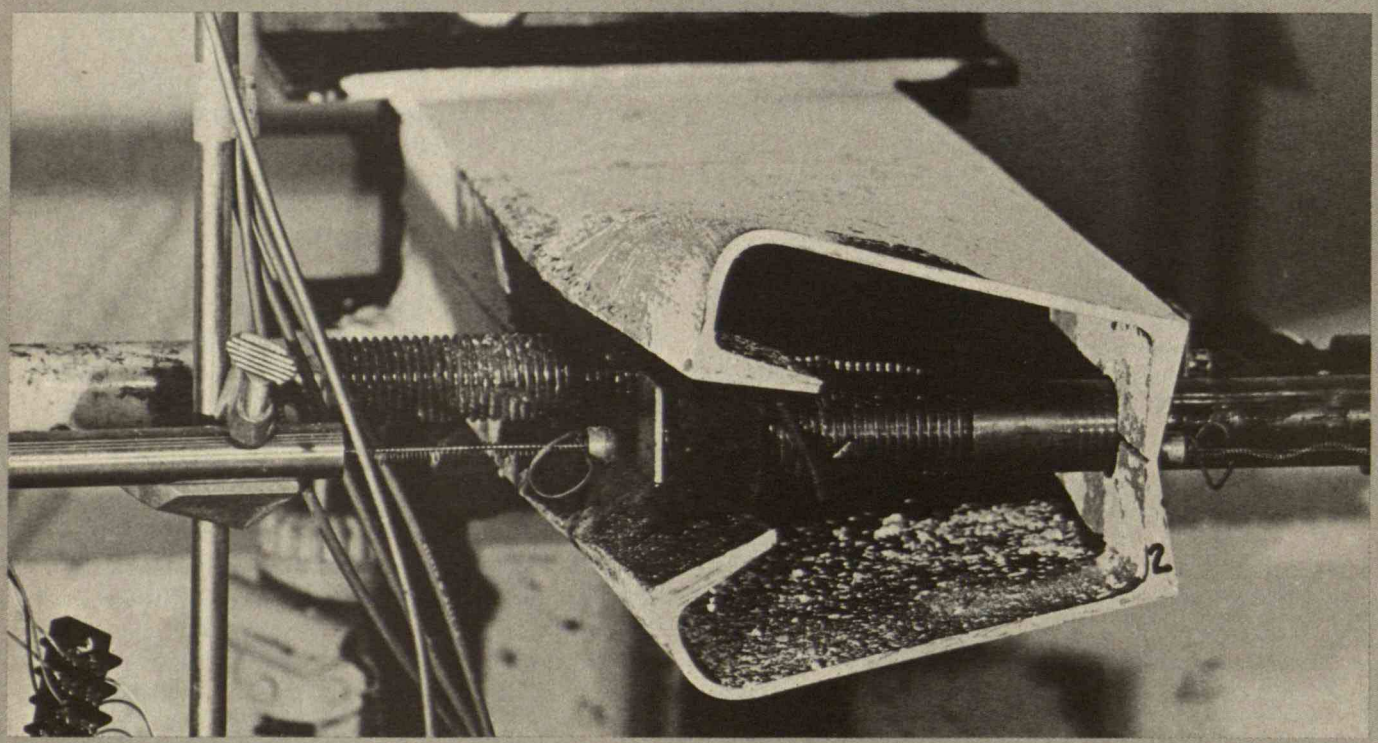
However, if the lower rope-hanger grabs not the same rope but another one tied to the legs of the person above, the upper person's grip must support two bodies, roughly twice the original weight. If the top person's grip is just barely strong enough to support the doubled weight, it will eventually give out. The slightest wiggling of the lower person could loosen the upper's grip and send them both to the ground.

This is essentially what seems to have happened in Kansas City. Although the problem is easy to analyze in retrospect, it was not so readily foreseen amidst the myriad details of the unique construction situation.—*H.P.* □





This series of photos shows the result of a test performed by the National Bureau of Standards as part of the investigation into the walkway collapse. Researchers submitted a beam taken from one of the walkways to increasing loads. The rod that would have led from the ceiling to the fourth floor walkway pulled upward through the steel beam at a load slightly less than the estimated maximum load at the time of the failure.



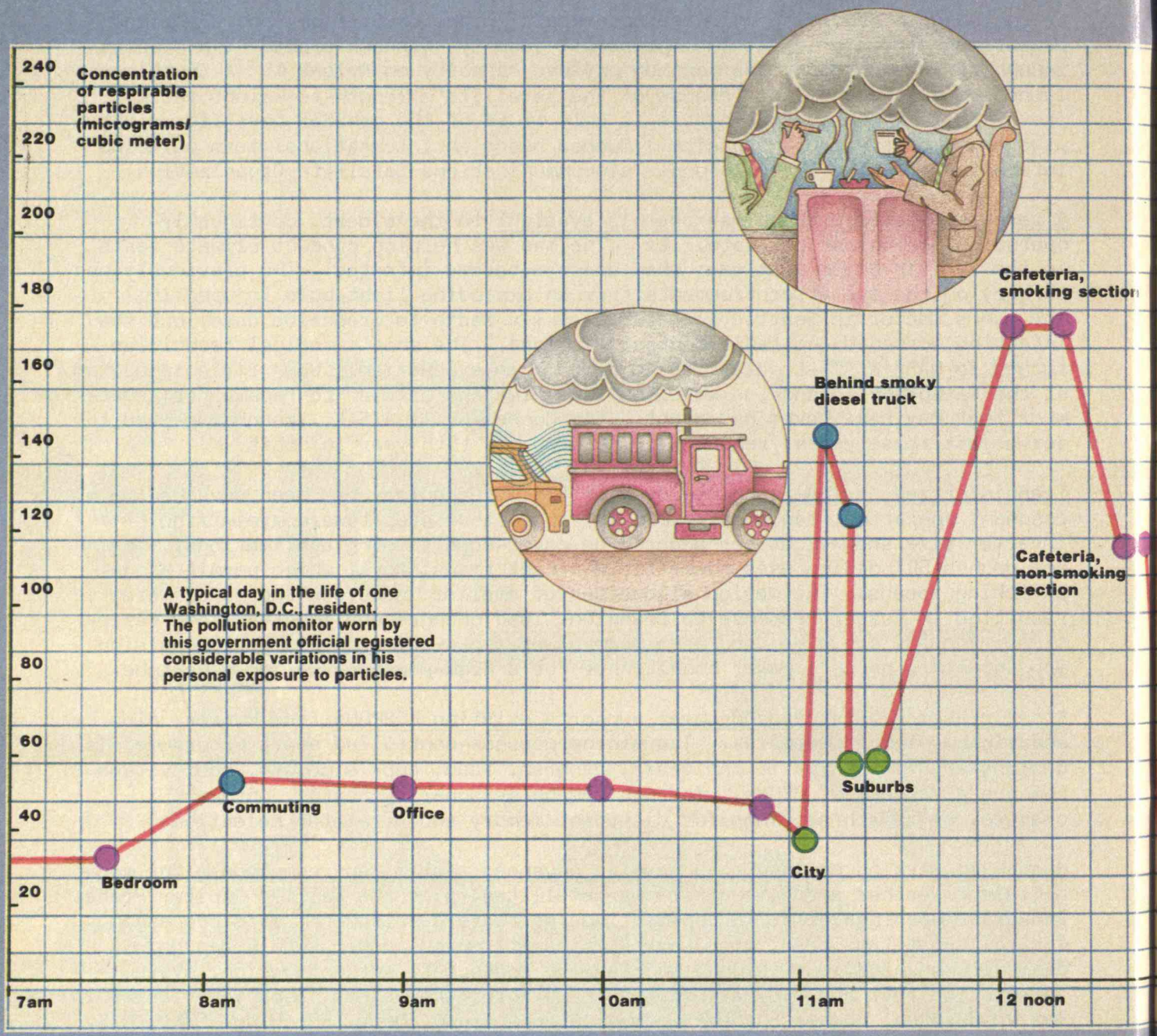
Intelsat VI communications satellites can be flown on either the Ariane 4 or the Space Shuttle. For an Ariane launch, the spacecraft is mated to the booster with a conical adaptor and clamp. A Shuttle launch requires additional hardware -- including a cradle to hold the spacecraft in the Shuttle bay and a perigee propulsion stage to inject the spacecraft into synchronous orbit. The compact launch arrangement provides maximum payload capacity on Ariane 4. A Shuttle launch is also economical because of the satellite's length-to-weight ratio. Its overall length in the Shuttle is only 44.6% of the orbiter bay; its weight uses 45.4% of available capacity. Hughes heads an international team building Intelsat VI for the International Telecommunications Satellite Organization.

A research vessel crewman may owe his eyesight to the oldest, continually-operating communications satellite. The man was helping conduct climate tests in the Pacific Ocean last year when one eye became infected. (He previously had surgery on the eye after fragments from an exploding light bulb injured it.) The man's doctor in Seattle was contacted via radio to prescribe care, but the infection worsened and radio contact was lost. The ship's medical technician turned to NASA's ATS-1 satellite to arrange an evacuation. When the ship docked at the Galapagos Islands, a waiting plane flew the crewman to Panama for treatment that may have saved his sight. The Hughes-built ATS-1, though expected to serve just three years, recently celebrated its 15th year in orbit.

Transistorized series-resonant-inverter (SRI) technology has been advanced to a resonant operating frequency of 200 kHz in another step toward minimizing inverter size and weight for spaceborne power-conditioning applications. The new Hughes SRI design uses power field effect transistors, which permit higher switching speeds. The design allows use of smaller inductors and capacitors, resulting in faster response to transient load changes and input-voltage variation. The SRI could be used as a beam power supply of an auxiliary propulsion ion thruster, or as a power conditioner for a high-power traveling-wave tube.

A new eraser/simulator/programmer supports existing EEPROMs from Hughes, plus additional planned memories. The microprocessor-controlled smart programmer is designated H3000 ESP. It can erase, program, read, copy simulate, modify, and compare a variety of PROMs. It requires no personality boards, hardware changes, or switch settings for different memory and parameter selections.

Hughes is seeking engineers to develop advanced systems and components for many different weather and communications satellites, plus the Galileo Jupiter Probe. Immediate openings exist in applications software development, data processing, digital subsystems test, microwave/RF circuit design, power supply design, digital communications, signal processing, spacecraft antenna design, system integration test and evaluation, and TELCO interconnection. Send your resume to Tom W. Royston, Hughes Space & Communications Group, Dept. SE, Bldg. S/41, M.S. A300, P.O. Box 92919, Los Angeles, CA 90009. Equal opportunity employer.



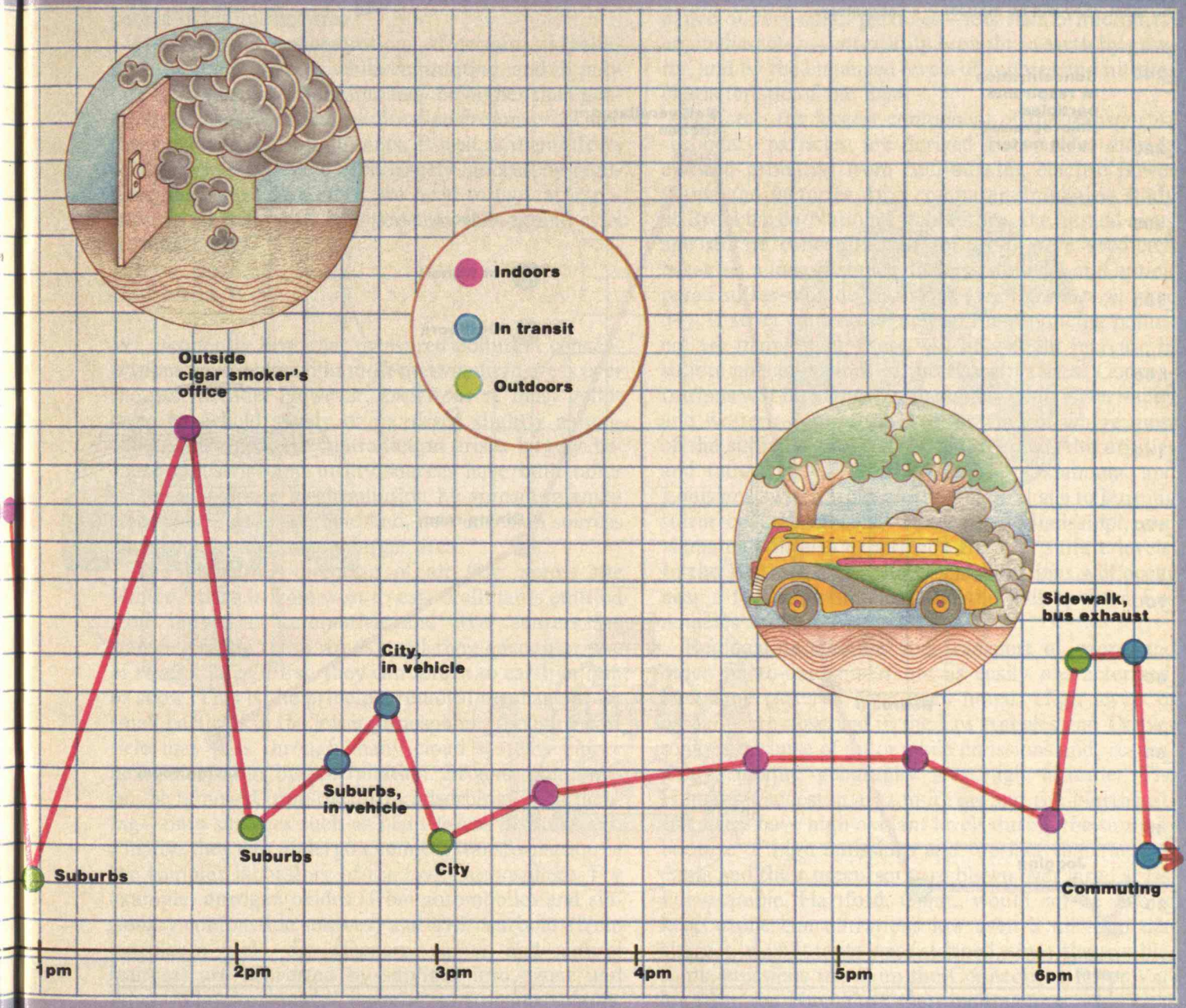
A typical day in the life of one Washington, D.C., resident. The pollution monitor worn by this government official registered considerable variations in his personal exposure to particles.

DAN COLLINS

Do you live in the east or west, country or city? What neighborhood? What kind of home? Although these factors greatly influence your exposure to air pollution, federal regulations don't take them into account.

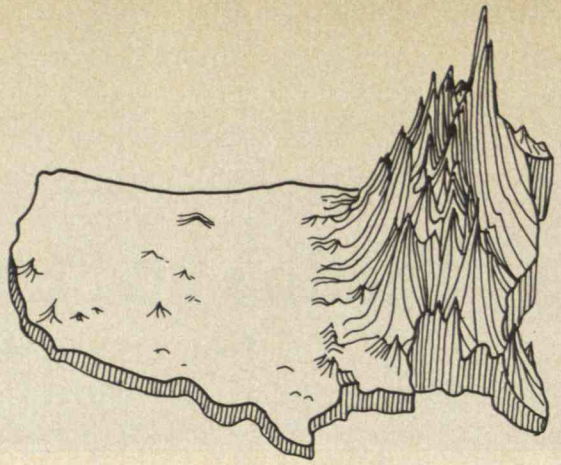
The In's and Out's of Air Pollution

by John D. Spengler and Steven D. Colome

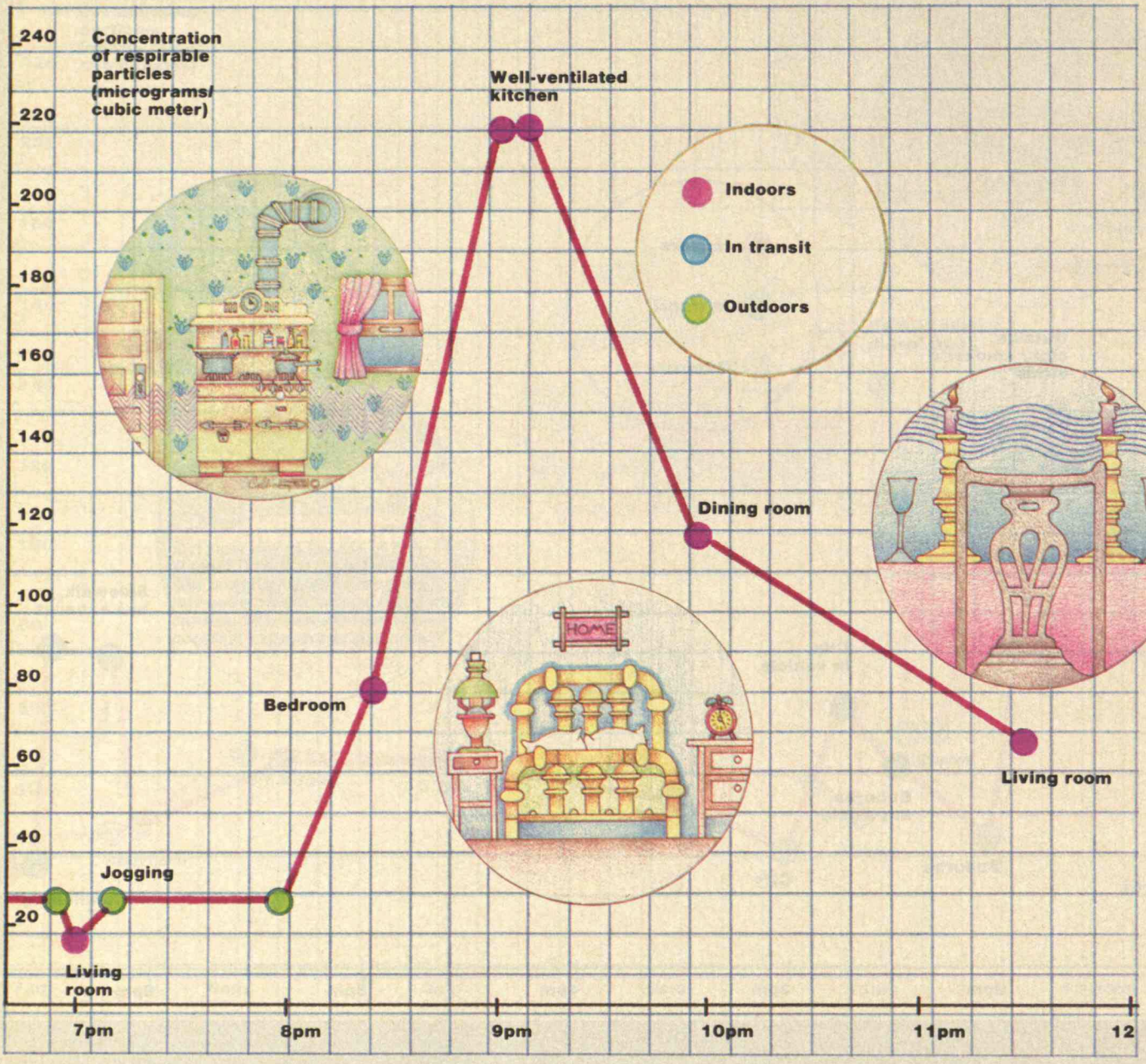


THE Clean Air Act of 1970 is one of the nation's most successful pieces of environmental legislation. It is also one of the most complex, controversial, and expensive—and is currently being reexamined, with heated debate, by Congress.

Passed at a time of heightened concern about pollution, and variously amended through 1977, the law required the U.S. Environmental Protection Agency (EPA) to set strict limits on major pollutants such as sulfur oxides, nitrogen oxides, and particles. And it has worked. During the 1970s, the number of days when air quality in major urban areas reached harm-



Right: Particulate sulfate pollution predicted for 1990. In the East, concentrations will be highest downwind of major coal-burning electric power plants and factories. In the West, they will be highest near a few large smelters and metropolitan areas. These annual sulfate levels were predicted in a computer-simulation study at Brookhaven National Laboratory.



ful levels declined by one-third. But the costs are substantial—although figures vary widely, business estimates that it must spend $16 billion annually to meet the standards—and many industries are actively lobbying for modifications.

At the core of the controversy is the extent to which adverse health effects result from exposure to current levels of air pollutants. The act's major goal is to manage air quality to protect human health, and the success of regulatory strategies has been mea-

Each region now must devise strategies within its boundaries to meet air-quality standards, but that is not always possible.

sured by the responses of concentrations of outdoor (ambient) pollutants. In this approach, outdoor pollution levels, measured at particular locations, are assumed to be the sole determinants of exposure of people living in that area.

However, the concentrations of certain air pollutants in homes, in cars while commuting, and in public places such as restaurants may be higher than generally measured in the outdoor environment. Thus, the sources of many pollutants, as well as their effects on human health, have been largely ignored by regulatory agencies. Therefore, we need to look at exposures to air pollutants on a personal, indoor, and even regional scale.

East versus West

We frequently hear that measured pollution concentrations have declined in most metropolitan areas over the past decade. However, *emissions* of most pollutants have held steady or increased slightly nationwide. This apparent contradiction arises largely because industrial and utility sources have built taller stacks that dilute local pollution by spreading emissions over a wider region. And, new emission sources have been located over a larger area.

The prevailing direction of air flow across the United States is from west to east. Pollutants emitted from industrial, automotive, and other sources are transported by these winds until they encounter one of several fates. First, they can return to earth in rain or snow. This is the principal removal mechanism for small particles in the lower atmosphere, though a particle may pass through many cloud systems before being swept out by precipitation. Second, pollutants can be removed from the air by adsorbing—or attaching—onto surfaces such as plant leaves or buildings. Finally, they can undergo chemical transformation in the complex laboratory of the lower atmosphere. For example, nitrogen oxides (from automobiles and stationary combustion sources) and hydrocarbons (from petroleum fuels, dry cleaners, paints, and natural sources) are converted by sunlight into ozone and other "photo-oxidants" harmful to humans, plants, and materials. Gaseous sulfur dioxide and nitrogen dioxide can also be oxidized into particulate sulfates and nitrates. These "secondary" products are then subject to the same removal mechanisms.

Because particles come both from direct emissions and conversion of gaseous emissions, they exhibit the most striking regional differences in concentration. The annual average particle concentrations in the air east of the Mississippi River are 5 to 25 micrograms per cubic meter higher than in most nonurban Western sites. This difference is caused mostly by an abundance of very small particles—less than 5 micrometers in diameter—not readily brought to earth by gravity, and by the enhanced levels of sulfates and nitrates characteristic of the East.

Sulfates, the largest component of the transported secondary particles, are derived from sulfur dioxide emitted primarily from coal-burning electric power plants and factories. In a computer-simulation study at Brookhaven National Laboratory, the annual average sulfate concentrations for 1990 were predicted based on a long-distance dispersion model and anticipated sulfur-dioxide emissions (*see the map on page 34*). If strict controls on new sulfur-producing polluters are maintained, there will be a slight increase in sulfate concentrations in the Eastern states. Concentrations will be highest in the upper Ohio River valley and western Pennsylvania, downwind of where most of the sulfur is released. If, as expected, the utilities and industries of Texas, Arkansas, Oklahoma, and Louisiana switch from burning natural gas to burning sulfur-containing coal, Tennessee, Mississippi, and Alabama will also experience elevated sulfate levels. In the Western states, high concentrations will occur near a few large smelters and the metropolitan Los Angeles and San Francisco areas.

Regional production and transport of ozone and other photo-oxidants is not as easily characterized, but some patterns have been noted. High levels of oxidants are observed in the Los Angeles and Denver regions because of automobile emissions and, respectively, unique geography and high altitude. The Houston-Galveston area in Texas and the Northeastern states have high oxidant levels during the summer because of high emissions and the fact that the oxidants and their precursors are blown over large areas. For example, Hartford, Conn., would not be able to keep ozone concentrations low even if all local discharges of pollutants were stopped, since the troublesome emissions travel up the Connecticut River Valley from the New York metropolitan area.

The Clean Air Act addresses interregional air pollution problems only indirectly. Such problems often originate outside the areas that must legally meet air-quality standards within their borders. For example, the inland California communities of Riverside and San Bernadino must contend with ozone originating largely from emissions in Los Angeles and Orange

Particles are often smaller in urban areas than in rural areas, making them easier to inhale and more likely to cause lung damage.

County. New York state experiences acid rain and high concentrations of particulate sulfate from emissions in Ohio and Pennsylvania. And Massachusetts, like Connecticut, receives ozone and its precursors from New York and New Jersey. However, each region must devise strategies *within* its boundaries to meet air-quality standards. Remedies are limited, and it is difficult to prove that other districts are to blame. Yet it is not always possible to meet standards with local controls alone.

The Clean Air Act also lacks standards for particulate sulfates and nitrates, the principal causes of acid rain, and does not mandate control programs. The most effective strategy for controlling these conversion products is to reduce total regional emissions of sulfur dioxide and nitrogen dioxide. Therefore, strict limits are imposed on emissions from late-model automobiles and new industrial facilities. However, existing facilities emit such large amounts of the pollutants that these sources must be controlled as well. But the Clean Air Act does not authorize such controls. In any case, conversion of industrial facilities from oil and natural gas to coal may nullify the gains.

Urban Problems

What city, and what section of that city, people choose to live and work in can affect their exposure to several gaseous and particulate pollutants. Because there are more stationary and mobile emission sources in urban areas, concentrations of sulfur dioxide, nitrogen dioxide, carbon monoxide, and particles are often two to five times higher than in surrounding rural areas. And within urban areas, pollutant concentrations often change over distances as small as ten to a few hundred meters. For example, pollution levels immediately adjacent to industrial sources, dusty vacant lots, and roads can increase dramatically.

A 1979 study of the St. Louis region by the EPA found that average annual concentrations of "total suspended particulate matter" in urban industrial centers were nearly twice the levels observed outside the city. Particles in urban areas are also smaller in size than in rural areas, making them easier to inhale and therefore more likely to cause lung damage. Within industrial areas, concentrations of fine (respirable) particles are highest around local emission sources.

The chemical composition of particles also varies markedly within and among cities, reflecting differences in local and regional sources. Studies in Denver, St. Louis, and Portland, Ore., show that particulate composition (its content of carbon, sulfate, inorganic minerals, and metals) is quite distinct in each of these cities. And urban pollutants often have unique "signatures" produced by the different mixes of local industrial sources.

One important particulate variable is acidity, which is suspected to affect a particle's biological potency—"the more acid, the more potent" seems to be the rule. On a neighborhood scale, people near cement plants are exposed to more alkaline particles, while those near coke plants breathe more acidic particles. On a larger scale, the sulfates over rural areas are more acidic than over urban regions. This is because the acidity of sulfates is partially neutralized by ammonia, which is found in higher concentrations in urban areas. (But introducing another wrinkle, cattle and dairy farms generate considerable ammonia, so nearby residents should face a reduced threat from acidity.)

The Clean Air Act does not differentiate between particles of different sizes and compositions, except for a few separately controlled hazardous substances. It simply sets limits—by weight—on the total amount of particles allowed in the air. But particles produced by industries and automobiles, though lighter, are actually most hazardous, since they are easiest to breathe, remain in the air longest, and—because they derive almost exclusively from technological processes—are most likely to contain toxic chemicals rare or unknown in nature.

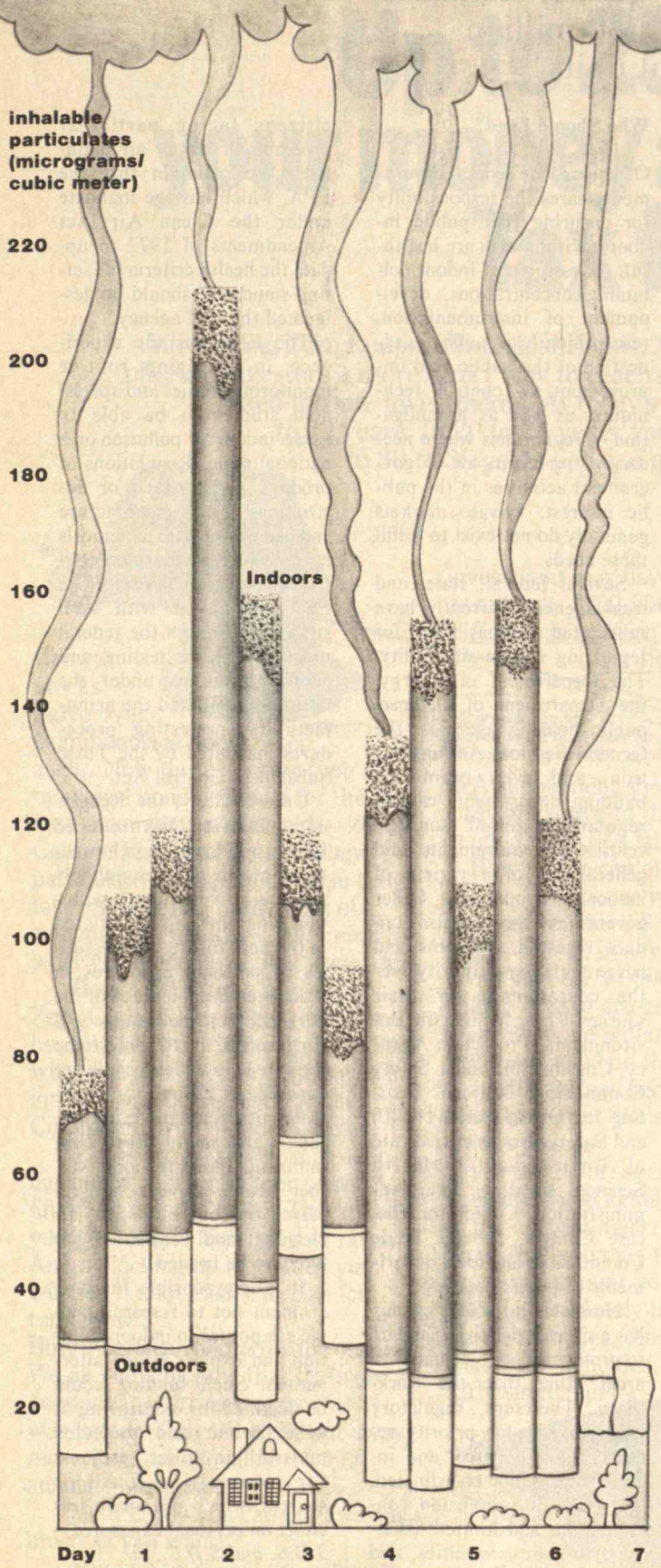
Dirty Indoor Air

Studies indicate that most people in the United States average 80 to 90 percent of their time indoors and 5 to 10 percent in a vehicle. Therefore, levels of indoor pollution are very important in determining people's total exposure. Concentrations of air pollutants in buildings can differ greatly from concentrations measured immediately outside, depending on the location of the source—whether inside or outside—and the chemical reactivity of the pollutant.

The relationship between concentrations of indoor and outdoor pollutants is complicated by wind speeds, building designs, and ventilation systems, as well as temperature, humidity, and pressure differences between inside and outside. "Porous" structures—those with forced ventilation to the outside or with open windows and doors providing natural ventilation—

(Continued on page 40)

Particle levels in the home of a pack-a-day smoker in Rio, Wisc., which was tightly sealed for energy conservation. The five occupants experienced total inhalable particle concentrations that greatly exceeded outdoor levels. When the smoker stopped, indoor particle concentrations dropped to roughly outdoor levels.



The Inside Story: Health and Regulations

FEW studies have attempted to relate the concentration of indoor residential air pollutants with health effects. For certain pollutants such as radon and carbon monoxide, evidence from occupational, community, or toxicological studies can be used to assess the risk of exposure to known concentrations. For other pollutants such as formaldehyde and "passive" cigarette smoke, evidence is not strong enough to estimate risk. However, even if reasonable risk estimates can be made for *specific* exposures, projections of overall health effects from residential air pollution would be uncertain. This is because there is little information on the distribution of concentrations of toxic and potentially toxic materials in buildings.

Pollutant concentrations within homes vary widely according to weather, construction, cooking styles, cleaning schedules, smoking habits, and hobbies. Determining how these factors influence human exposure to the long list of potentially hazardous air pollutants would require a massive research program, conducted in a large sample of homes in different parts of the country and at various times of the year.

Despite the uncertainties, however, several generalizations are possible. Harmful pollutants from indoor sources are sometimes found in higher concentration inside homes than in heavily polluted outdoor urban air. These include nitrogen dioxide and carbon monoxide from gas appliances, passive cigarette smoke, radioactive radon gas from decay of radium in the ground and in building materials, formaldehyde from furnishings and building materials, and asbestos and other mineral fibers in ceiling and floor tiles.

Adverse health effects from all these indoor pollutants have been documented, but sometimes at concentrations higher than generally observed within homes. Carbon monoxide is an asphyxiant that is deadly upon high-level, short-term exposure. At lower concentrations, it affects the heart, brain, and skeletal muscles, and persons with cardiovascular disease may suffer increased chest pain at relatively low concentrations.

Nitrogen dioxide within homes increases respiratory infections and decreases lung function in children. Infants exposed to passive cigarette smoke are more likely to have bronchitis, pneumonia, and respiratory symptoms. In nonsmoking adults, long-term exposure to passive cigarette smoke seems to increase the risk of lung cancer and decrease the small-airway function of the lungs. Radioactivity from radon can cause lung cancer, but this link has been positively identified only in uranium miners exposed to much higher concentrations. Asbestos can cause pulmonary fibrosis and lung cancer and is found in high concentrations indoors when asbestos-containing materials are damaged. Formaldehyde irritates the eyes, throat, and lungs and can cause nausea, headache, thirst, fatigue, and rash. This gas has also recently been found to cause nasal cancers in laboratory rats.

Other pollutants, which are primarily of outdoor origin and/or very chemically reactive, are generally found in higher concentrations outdoors. These include sulfur dioxide, ozone and other photochemical products, and combustion-derived particles. Since the indoor concentration of these pollutants is lower, the home partially protects against their effects. But iron-

(Continued on next page)

The government cannot establish indoor air-quality standards for the nation's 80 million residential units.

ically, this protection may confuse the results of community studies designed to determine the effect of outdoor air pollutants on human health. Such studies *assume* that people are exposed to pollutant concentrations measured by outdoor monitors. But since individual exposures are different from what is measured by these outdoor monitors, the studies can err either on the high or low side.

What Can Be Done?

Regulating indoor air quality is more complicated than regulating outdoor air quality. Ambient air quality is considered a "public good" that usually is degraded because the prices charged for energy production, manufacturing, and transportation do not adequately take into account the costs associated with pollution. However, indoor air quality can be degraded by both outdoor and indoor sources. Building occupants are often responsible for the purchase and use of many indoor pollution sources, and they can control the rate of incoming "fresh air" through ventilation.

No one seriously argues that the federal government should establish indoor air-quality standards for the nation's 80 million residential units—enforcement would be impossible as well as undesirable. Source controls, product performance specifications, building ventilation requirements, and construction codes are more reasonable regulatory options.

The 1981 report by the National Academy of Sciences (NAS) on indoor pollutants stated that source control should be the first option considered to protect the quality of indoor air. Specific control measures vary by contaminant. For example, exhaust hoods can be installed to reduce emission of nitrogen dioxide and carbon monoxide from gas ranges, walls and floors can be coated with sealant to prevent the release of radon, the use of asbestos-containing products can be prohibited, and no-smoking areas can be designated in public buildings.

Where those strategies cannot provide adequate control at reasonable cost, they can be supplemented or replaced by engineering controls such as ventilation (dilution) or air cleaning. Air-cleaning devices are used in large indoor commercial, industrial, and institutional environments, but their cost, size, and noise limit their use in homes. Moreover, the effectiveness of air-cleaning devices usually depends on frequent maintenance. But these devices are becoming smaller, cheaper, and quieter, and sales are projected to reach $2 to $6 million in 1982.

The NAS report stated that building owners and operators are responsible for ensuring that at least minimal ventilation standards are met. However, there is little or no enforcment of ventilation standards once building plans are approved. The NAS also recommended that architects, engineers, and contractors treat maintenance of indoor environmental quality as a design objective. Indeed, there are many ways to design buildings to separate people from pollution sources or to remove the sources completely.

Manufacturers are responsible for warning consumers of the potential hazards of products, especially from their misuse in poorly ventilated environments. Manufacturers and their trade associations should also sponsor research on the health and control aspects of contamination resulting from their products.

Who Should Lead?

Of course, the federal government shares the responsibility for ensuring that public indoor environments are healthful. Assessment of indoor pollutant concentrations, development of instrumentation, research on health effects, education of the public, and improvement of control techniques, as well as promulgation of regulations where necessary, are examples of government activities in the public interest. Private markets generally do not exist to fulfill these needs.

Several federal, state, and local agencies currently have substantial responsibility for regulating indoor air quality. The Department of Energy, the Department of Defense, public housing agencies, the General Services Administration, and even municipal building departments can all regulate pollutant sources, ventilation requirements, and general use of a variety of indoor environments. Other government agencies also conduct research programs and have regulatory authority over the contaminants or their sources. These include the Environmental Protection Agency, Consumer Product Safety Commission, National Institute for Occupational Health and Safety, National Institute of Environmental Health Sciences, Food and Drug Administration, Center for Disease Control, Federal Trade Commission, and local departments of public health.

However, no single agency has a clear legislative mandate to protect indoor air quality in areas other than the workplace. Therefore, regulatory efforts receive low priority, research is duplicated, and information is not coordinated. This has led to confusion, contradiction, and limited assistance to states, localities, and citizens facing particular problems of indoor air pollution. We maintain that the EPA, which has the mandate under the Clean Air Act Amendments of 1977 to update the health criteria for setting standards, should be designated the lead agency.

The EPA has the experience in managing routine monitoring studies and special field studies to be able to assess indoor air pollution on a national scale. Regulations of product performance or restrictions on the manufacture and use of certain chemicals may also be necesary to control indoor air pollution. The EPA is familiar with such strategies through the federal mobile emission testing and control programs under the Clean Air Act, and the manufacturers' pretesting procedures mandated by the Toxic Substances Control Act.

Unfortunately, the Reagan administration has reduced EPA's staff and research functions, and it appears unlikely that any new indoor air pollution programs will be initiated in the near future. Some studies of personal exposures in indoor environments will be pursued, but the results will be insufficient to determine the extent to which people are exposed to radon, formaldehyde, nitrogen dioxide, molds, fungi, and many other contaminants found indoors. Neither health surveys nor research on source control, air cleaning, and ventilation are likely to be funded.

It is irresponsible for government not to research people's exposure to indoor pollution and explore policy alternatives. Such funding could be justified by comparing it with current and projected multibillion-dollar projects for controlling outdoor sources, which may have less effect on personal exposure.—*J.D.S. and S.D.C.* □

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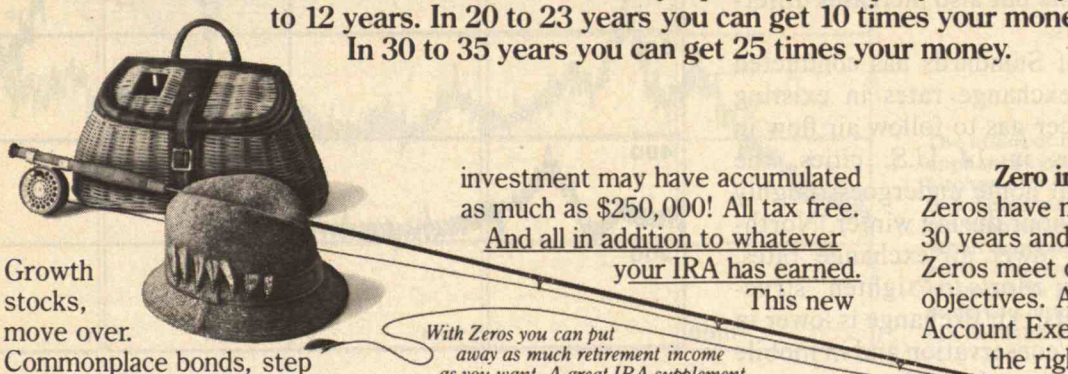

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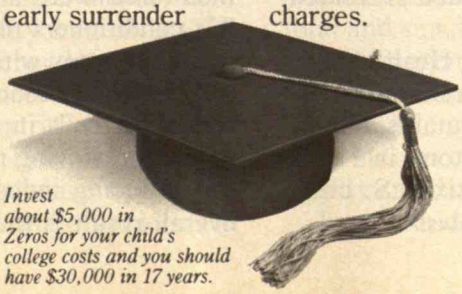

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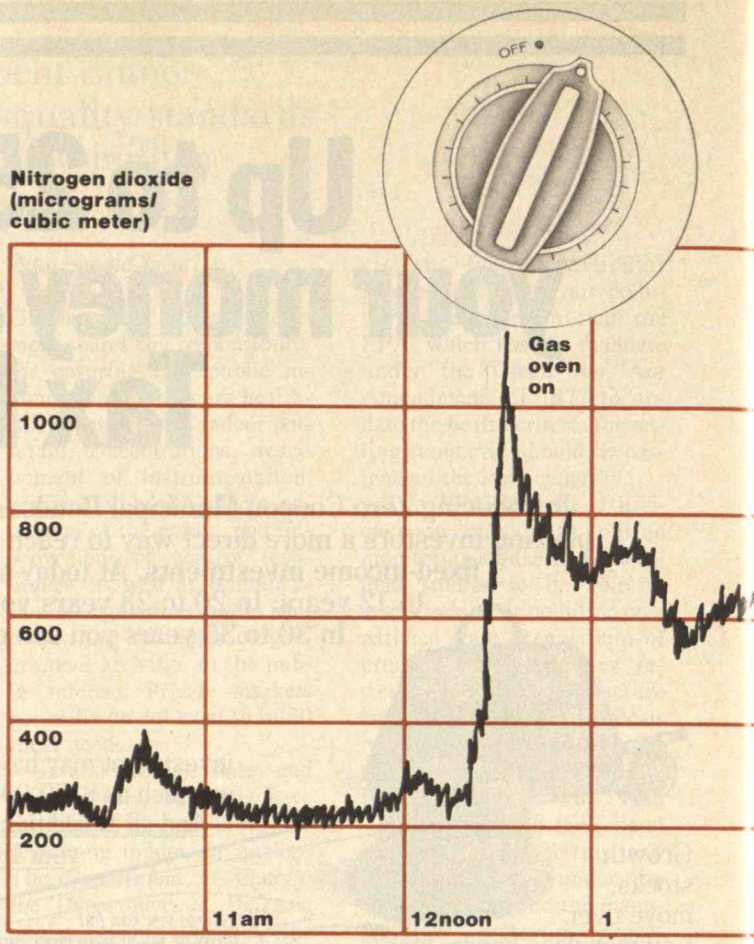
(*Continued from page 36*)
will have roughly similar pollutant concentrations inside and out. But many new buildings are being designed with reduced air infiltration to conserve energy. Existing buildings are also being remodeled. Caulking air leaks and installing storm windows and doors are common strategies for reducing air infiltration, and building engineers are shutting air vents in many public and commercial buildings. Reducing the number of air exchanges between inside and out lowers heating and cooling costs but also increases differences in air pollution levels.

The National Bureau of Standards has conducted the largest study of air-exchange rates in existing homes. Using an inert tracer gas to follow air flow in approximately 300 homes in 14 U.S. cities, the bureau found that a typical home undergoes roughly one full air exchange each hour during winter. Northern cities generally have lower air-exchange rates, probably because of greater efforts to "tighten" structures to reduce heating costs. Air exchange is lower in homes designed for energy conservation and in mobile homes, with full exchange occurring only every two to ten hours. However, on a mild day with light winds and a small temperature difference between inside and outside, *any* building without forced ventilation will have almost negligible air exchange.

Indoor pollution in residences, public buildings, and offices is created largely by occupants' activities and their use of appliances, power equipment, and chemicals; wear and tear and "outgassing" of structural or decorative materials; thermal factors; and intrusion of outdoor pollutants. Outdoor pollutants that penetrate indoors sometimes represent the most important pollutant stress on human health and welfare. In these cases, pollutant standards established by the Clean Air Act help maintain acceptable concentrations. But the act does not cover pollutants generated indoors, and their concentrations often cause significant health problems (*see "The Inside Story: Health and Regulations," page 37*). Some pollutant sources such as cigarettes have been recognized for a long time. Other pollutants arise from new products or a resurgence of old energy sources such as residential coal, wood, and kerosene stoves.

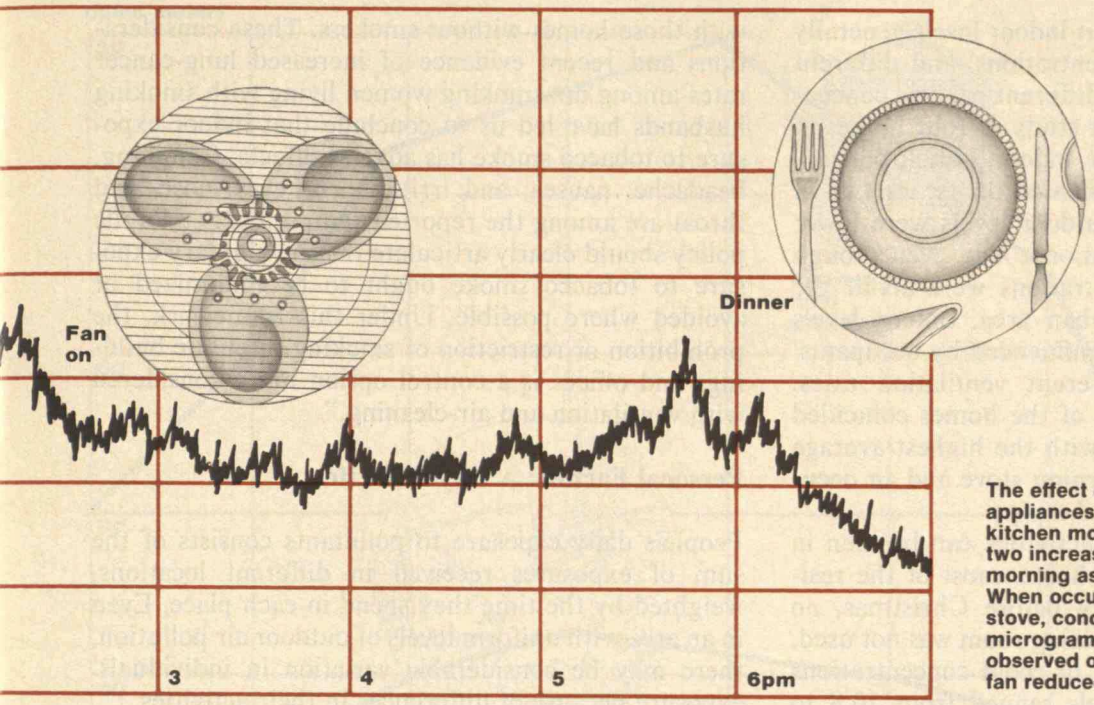
In the Harvard Air Pollution—Lung Health Study, which began in 1974, we have monitored indoor and outdoor concentrations of several pollutants, as well as lung functions and respiratory symptoms in 12,000 children and 10,000 adults living in six U.S. cities. Some results, by pollutant, are as follows:



Sulfur Dioxide. Indoor sources are generally negligible, and sulfur-dioxide concentrations range from 20 to 90 percent of outdoor values. Given differences in air-exchange rates, air-conditioning, and air-cleaning equipment, neighboring structures experiencing the same ambient pollution can have indoor concentrations that differ by more than a factor of two.

One city we investigated was Watertown, Mass., where we monitored 12 homes without central air-conditioning. During the summer, outdoor sulfur-dioxide levels are low and home ventilation rates are high, so indoor and outdoor concentrations are about equal. In winter, outdoor levels are higher but ventilation rates are lower. Therefore, the slower rate of infiltration allows the sulfur dioxide to adsorb onto interior surfaces, and indoor air concentrations are considerably lower.

In the industrial town of Steubenville, Ohio, the picture is somewhat different. Outdoor sulfur-dioxide levels are much higher, but most of the 10 homes monitored were air-conditioned and tightly sealed. Air conditioners recirculate indoor air, lowering air-exchange rates with the outside and hence reducing sulfur-dioxide concentrations indoors. Also, the wet condenser coils in the air conditioners absorb sulfur dioxide, removing much of it from the circulating air and reducing indoor concentrations even more. The overall result is that the homes in Steubenville have



The effect of common household appliances on indoor air pollution. In this kitchen monitored on a Sunday, there were two increases in nitrogen dioxide in the morning as the hot-water heater turned on. When occupants cooked brunch on a gas stove, concentrations exceeded 1,000 micrograms per cubic meter, a level rarely observed outdoors. Turning on an exhaust fan reduced contamination.

indoor sulfur-dioxide levels that are a much smaller percentage of outdoor levels compared with the Watertown homes—though the Steubenville homes still have roughly double the indoor concentrations.

Nitrogen Dioxide. In the absence of gas appliances, indoor nitrogen-dioxide concentrations are generally 50 to 60 percent of outdoor levels, depending primarily on air infiltration rates and indoor removal by chemical reactions. However, gas-burning appliances will increase nitrogen-dioxide concentrations well above outdoor levels. Gas stoves are most important, although gas hot-water heaters, dryers, and unvented gas and kerosene space heaters make sizable contributions. Also, the practice by some families in Northern cities of using their gas ovens for extra heat can greatly increase nitrogen-dioxide concentrations.

For 137 homes in the semirural community of Portage, Wisc., outside nitrogen-dioxide levels were relatively low (15 micrograms per cubic meter). But we found that 10 percent of the kitchens equipped with gas stoves had average annual nitrogen-dioxide concentrations above current air-quality standards (100 micrograms per cubic meter). Kitchen levels in these homes averaged five times outdoor levels, and even in bedrooms, nitrogen-dioxide concentrations were two to three times higher than outside. However, kitchens with electric stoves had nitrogen-dioxide concentrations slightly below outdoor levels. Pollutant levels in gas-stove kitchens declined by about half during the summer—most likely because of increased natural ventilation—but remained well above outdoor levels. Summer levels increased in electric-cooking homes as ventilation allowed more nitrogen-dioxide to enter, so indoor and outdoor concentrations were about equal (*see the chart on page 43*).

Nitrogen-dioxide levels vary greatly during the course of a day. For example, we plotted the concentrations in a gas-stove-equipped kitchen for nine hours on a Sunday (*see the chart above*). For six hours, concentrations averaged over 500 micrograms per cubic meter, levels only infrequently observed in outdoor air. There were two increases in nitrogen dioxide in the morning as the hot-water heater turned on. A family brunch cooked about noon increased levels to above 1,000 micrograms, and a final peak followed preparation of Sunday dinner.

Particles. Because of the many indoor sources of particles, a recent study by the National Academy of Sciences concluded that indoor concentrations of total and small particles, organic compounds (including carcinogenic benzopyrene), and certain metals are often higher than in any outdoor environment. In fact, daily and long-term averages of particle concentrations indoors can exceed current national ambient air-quality standards.

Tracer studies indicate that submicrometer parti-

Because most people in the U.S. spend 80 to 90 percent of their time indoors, determining the level of indoor air pollution is critical.

cles can penetrate indoors, but indoor levels generally do not reflect outdoor concentrations, and different homes in the same city have different particle concentrations. For example, in our study of four homes in the Boston area during winter, indoor particle concentrations were much higher than outdoors; for two of the homes, the maximum outdoor levels were lower than indoor mean concentrations. And even though the outdoor particle concentrations were about the same throughout the suburban area, indoor levels fluctuated greatly, probably influenced by occupants' activities coupled with different ventilation rates. Peak particle levels in three of the homes coincided with parties, and the home with the highest average indoor levels had a wood-burning stove and an occupant who occasionally smoked a pipe.

The influences of human activities can be seen in another way as well. In one home, most of the residents were away on the day before Christmas, no meals were cooked, and the dining room was not used. On that day, the uniformity of room concentrations was remarkable: indoor levels ranged from 20.8 to 22.8 micrograms per cubic meter, while the outdoor level was 22.7 micrograms per cubic meter.

Tobacco smoke is one of the most common sources of indoor particles. Over 54 million Americans—roughly a quarter of the population—smoke some 615 billion cigarettes per year, and nearly everyone else breathes the "passive" smoke, many on a daily basis. Working with researchers from Lawrence Berkeley Laboratory, we monitored a home in Rio, Wisc., that was tightly sealed (average air exchange of 0.3 per hour) and had a pack-a-day smoker living there (*see the chart on page 37*). The five occupants experienced particle concentrations that greatly exceeded outdoor levels, occasionally by five times. On the last two days of monitoring, the smoker stopped and indoor particle concentrations dropped to roughly outdoor levels.

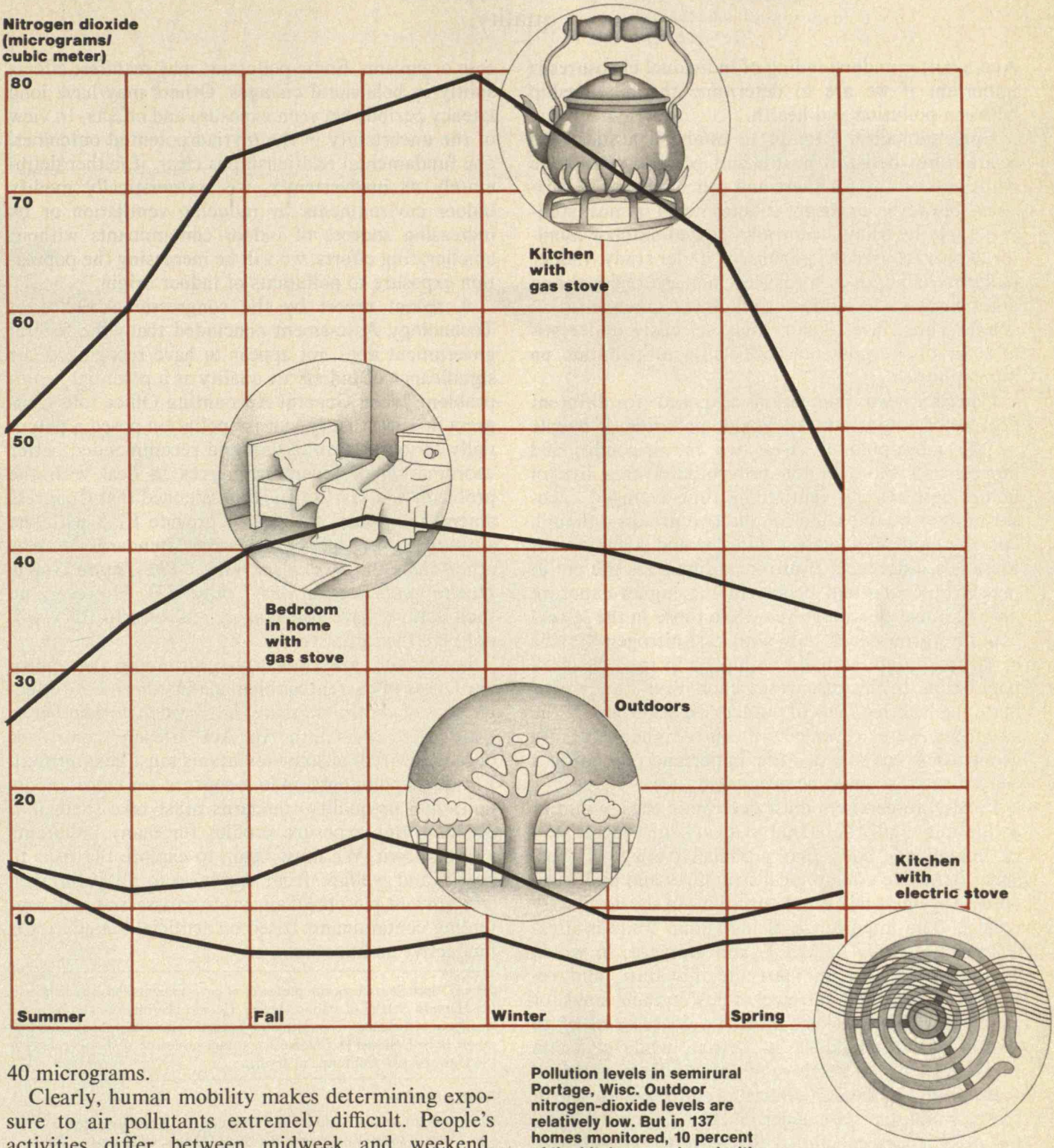
The effects of smoking can be even more troublesome in other indoor situations. For example, several studies have reported particle levels from 100 to 1,000 micrograms per cubic meter in bars, restaurants, transportation facilities, and vehicles. Because tobacco smoke is ubiquitous, the National Academy of Sciences stated in its report: "The constituents of tobacco smoke are well documented as hazardous, the prevalence of population exposures is very high, and there is an increased incidence of respiratory tract symptoms and functional decrements [decreases] in children residing in homes with smokers, compared with those homes without smokers. These considerations and recent evidence of increased lung-cancer rates among nonsmoking women living with smoking husbands have led us to conclude that indoor exposure to tobacco smoke has adverse effects. Coughing, headache, nausea, and irritation of eyes, nose, and throat are among the reported symptoms. . . . Public policy should clearly articulate that involuntary exposure to tobacco smoke ought to be minimized or avoided where possible. Under this framework, the prohibition or restriction of smoking in public buildings and offices is a control option to be considered with ventilation and air-cleaning."

Personal Factors: A Day in a Life

People's daily exposure to pollutants consists of the sum of exposures received in different locations, weighted by the time they spend in each place. Even in an area with uniform levels of outdoor air pollution, there may be considerable variation in individuals' exposure because of differences in their activities.

Although there have been few studies in this area, in one instance, James L. Repace, a government official in Washington, D.C., wore a portable pollution monitor to record his typical day (*see the chart on page 32*). His exposure to respirable particles varied from 30 micrograms per cubic meter outdoors to 230 micrograms per cubic meter in the kitchen while cooking. While he was driving behind a smoking diesel truck, his particle exposure hit 140 micrograms, and while he was sitting in his cafeteria smoking section at noon, he registered a level of over 150 micrograms per cubic meter.

In our study, we monitored 46 people for exposure to respirable particles in Topeka, Kans. Measurements were made of general outdoors and indoor levels, as well as by individual monitors. Concentrations measured by the personal monitors and within homes correlated only weakly with levels recorded outdoors. Indeed, personal exposures averaged two and a half times outdoor levels. Personal exposures correlated more closely, but not exactly, with indoor levels, and the match was stronger for women (none worked outside the home) than for men. Obviously, the subjects were exposed to high particulate pollution during some aspect of their daily activities. Smoke from other people's cigarettes accounted for much of this additional exposure: volunteers reporting no exposure to passive smoke during the day averaged 20 micrograms per cubic meter, while those exposed averaged



40 micrograms.

Clearly, human mobility makes determining exposure to air pollutants extremely difficult. People's activities differ between midweek and weekend, among seasons, and during different life stages. Activities vary with age, sex, occupation, and weather, as well as social, economic, and educational factors. Thus, knowledge of human behavior and activity patterns is essential in estimating personal exposures.

Pollution levels in semirural Portage, Wisc. Outdoor nitrogen-dioxide levels are relatively low. But in 137 homes monitored, 10 percent of the kitchens equipped with gas stoves had average annual concentrations above the current air-quality standard of 100 micrograms per cubic meter. Kitchen levels in these homes averaged five times outdoor levels, and even in bedrooms, the levels were two to three times higher than outdoors.

No single government agency has a clear legislative mandate to protect indoor air quality.

And a better understanding of individual exposures is important if we are to determine the relationship between pollution and health.

Epidemiologists attempt to establish a statistical relationship between health and pollution exposure while accounting for these and other influential variables. However, exposure is determined in most studies simply by using a centrally located outdoor monitor to characterize the population under study. Indoor pollution is not even measured, nor are regional and other large-scale outdoor differences taken into account. Thus, investigators may seriously underestimate or overestimate the effects of air pollution on human health.

Consider two populations exposed to different degrees of outdoor sulfur-dioxide pollution. If people in the more-polluted area live in air-conditioned homes, and those in the less-polluted area live in homes with natural ventilation, time-averaged exposure might be the same for the two groups—though current epidemiological studies would assume that there is a difference. If nitrogen-dioxide is the pollutant in question and people in the higher-exposure group all use electric stoves while those in the lower-exposure group cook only with gas, nitrogen-dioxide exposures might actually be higher in the "cleaner" population. In this case, researchers would underestimate the health effects of outdoor air pollution. If the situation were reversed—if the higher-exposure group used gas stoves—the importance of outdoor concentrations would be overstated.

Finally, researchers must determine the amount of pollutant actually delivered to a particular location in an individual's body that produces damage. Differences in people's anatomical structures and biological defense systems will cause variations in the doses they receive. The importance of individual traits is illustrated by a study at M.I.T. and Harvard, in which volunteers inhaled an inert metallic dust, and researchers monitored the level of dust in their lungs for 10 months. Nonsmokers showed a decrease of 85 to 95 percent of the dust by weight, while cigarette smokers showed a decrease of only 30 to 55 percent.

Because the health effects of different doses of most air pollutants are uncertain, the National Academy of Sciences concluded that careful judgment in determining safe levels of polluants is required: "Some pollutants may exert effects only at concentrations above a threshold; others may have no threshold. There may be synergism between pollutants or between pollutants and temperature, humidity, or disease organisms. Some pollutants may manifest effects subtly in behavioral changes. Others may have long latency periods between exposure and effects. In view of the uncertainty in the myriad potential outcomes, one fundamental relationship is clear: if, either deliberately or inadvertently, we systematically modify indoor environments by reducing ventilation or by increasing sources of indoor contaminants without ameliorating efforts, we will be increasing the population exposure to pollutants of indoor origin."

A recent report by the congressional Office of Technology Assessment concluded that "the federal government does not appear to have recognized the significance of indoor air quality as a potential health problem." The General Accounting Office told Congress in 1980 that indoor air pollution posed a potentially serious health hazard and recommended better coordination of federal resources to deal with the problem. The GAO also recommended that Congress amend the Clean Air Act to provide EPA with the authority to set indoor air-quality standards in areas other than the workplace (*see "The Inside Story: Health and Regulations," page 37*). However, no such actions have been taken, and clearly EPA will not take the initiative.

Lawmakers are currently scrutinizing the appropriateness of current ambient standards and the effectiveness of control measures as they debate whether to reauthorize the Clean Air Act. Clearly, control of outdoor sources of some pollutants must be improved. For other pollutants, indoor sources are more important, and air-quality standards must take them into account. But exposure profiles for many pollutants are unknown. We must begin to explore the risks to health and welfare from exposure to all pollutants. The current piecemeal approach to assessing and regulating contaminants based on artificial boundaries is ineffective and unwise.

John D. Spengler is associate professor of environmental health sciences at the Harvard School of Public Health. He was chairman of the National Academy of Sciences Committee on Indoor Pollutants, which issued its report in 1981. **Steven D. Colome** is assistant professor of social ecology at the University of California at Irvine.

Further Reading

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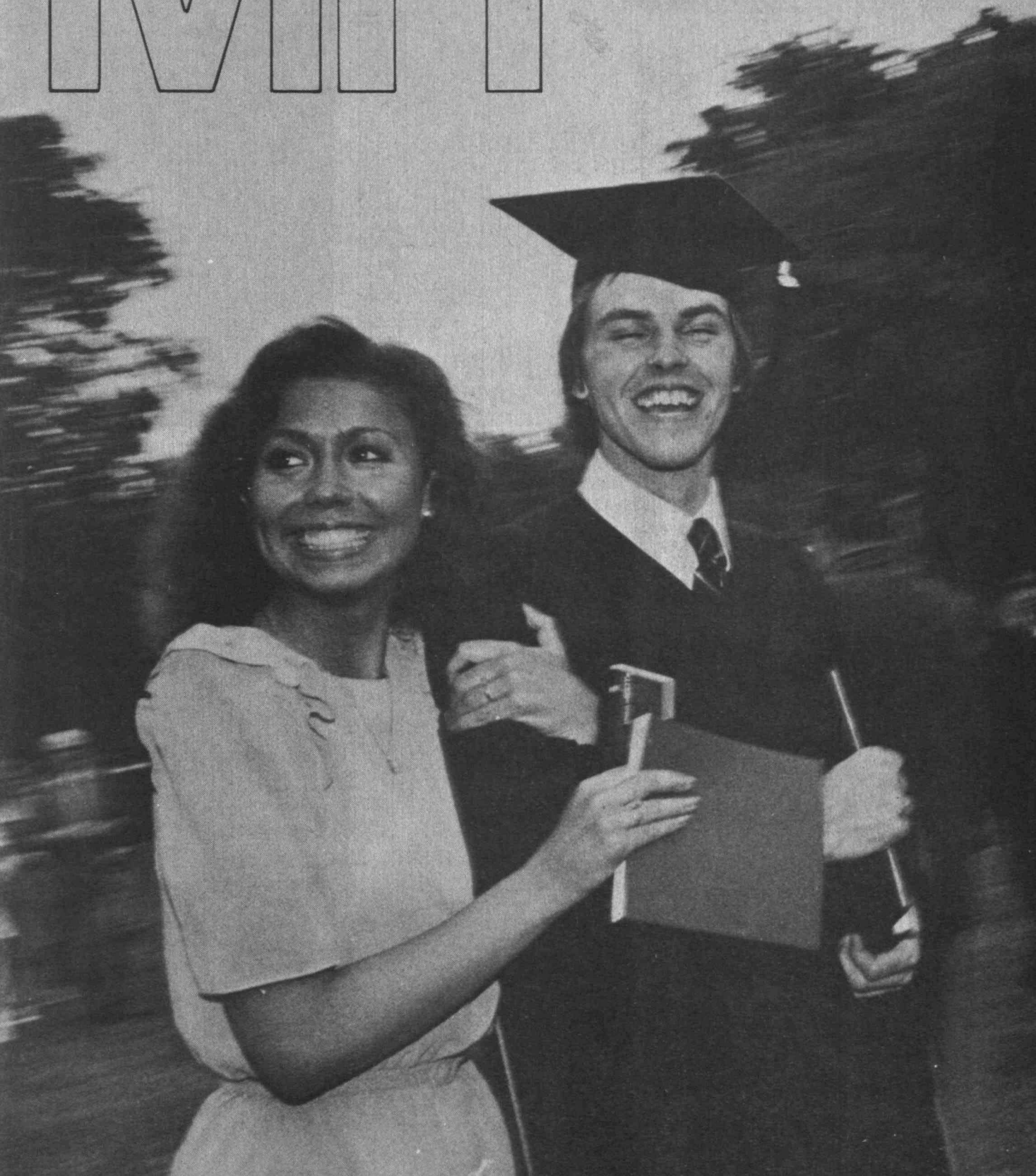
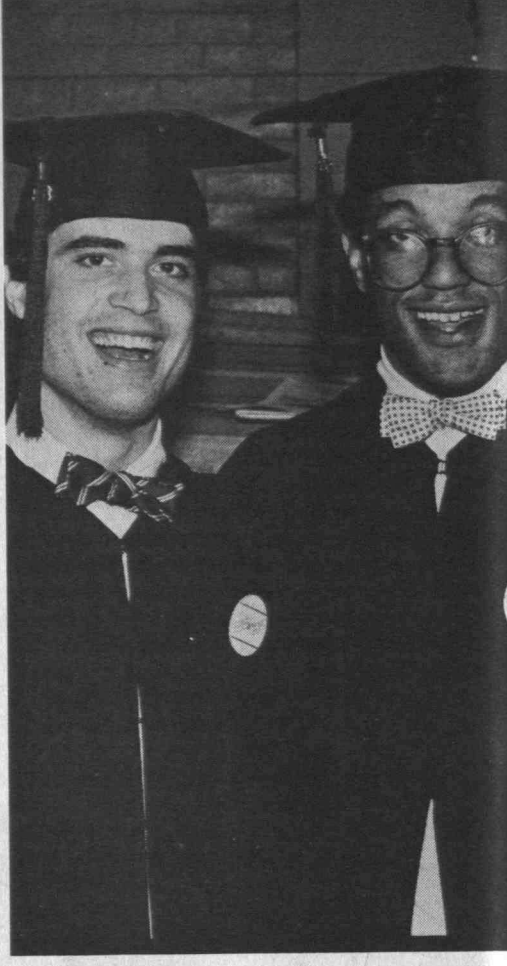
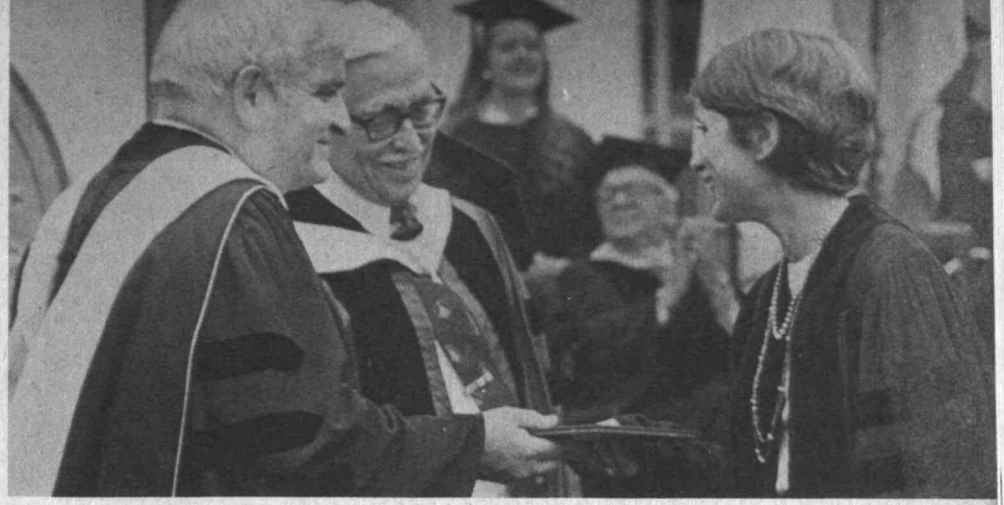
MIT

Graduation Photos: Scott J. Globus, '84







Paul M. Fye, president of the Woods Hole Oceanographic Institution (center) joined President Paul E. Gray, '54, of M.I.T. in presenting nine degrees awarded jointly by MIT and WHOI at the graduation ceremonies in the Killian Court on June 1. (Photo: Calvin Campbell)

"This Is Your Time . . ." One of the Largest Classes in History Receives M.I.T.'s Final Approval

Commence: to initiate. 1.: to enter upon: begin. 2.: to initiate formally by performing the first act of. 3.: to have a beginning: start. to begin to be or to act as. 4.: chiefly Brit: to take a degree at a university.

Commencement is an end and a new beginning, a day with much for everyone—pageantry, pride, completion, family, celebration, accomplishment, and opportunity.

So many lives that were once separate are now united. Some will separate again, but in this one day, June 1, when 10,000 people join in the ceremony for 1,562 students receiving 1,623 degrees, a host of new ties among people and with an institution are cemented with a morter that will last a lifetime—or more.

The overriding emotion, amidst the *pageantry* of the event, is *pride*: support and congratulations fill the Killian Court. It signifies *completion*: four years is a long time when one is maturing and learning and changing so fast. It is for, in great part, the *family*: this is their day. They are together to support one member—sometimes two or even more—and they come from far and near to join together in acknowledgement and *celebration*.

And it signifies *accomplishment*. How often did they ask, "Will I really make it?" before that day. Some say "I won't believe it until I have it in my hand."

Opportunity is there too—countless doors will be opened with that degree. Even if the field of endeavor changes, the degree remains a tribute to one's ability to take on a challenge and complete it successfully.

Finality and Independence

Heartache, too, often comes with completion. Time to move on. "One day we leave home," says Charles Frankel, '82, senior class president. "One day school starts, and on another day it ends, and we're off on a new career. Parents come to deposit their child; they come back, four years later, on a much different occasion. Now there is a son or daughter assuming more independence. It's more final now. And that is as scary as it is exhilarating." There is an element of terror—being ejected, starting something completely new. Here, they are ensconced in a cozy environment that they know. Now begins more independence and responsibility—and out into the real world. The possibilities are enormous, and also the unknown quantities. By one single act, one is catapulted into a completely different environment.

Cumulative Details

The setting is perfect: a small brass choir on the steps of Massachusetts Avenue, nestled among the huge pillars. The procession starting from three different points and meeting at the Massachusetts Avenue entrance moves slowly around to stately Killian Court, the essence of tradition, grandeur, and solemnity. The large audience is enthralled with the symbols, robes, and pomp. Graduation smacks of all the occasions that mark the passage of time, the end of one era, the beginning of another. Like any huge production, a myriad of details make up the whole. Time marches irrevocably toward that final day when the crises invariably explode.

Planning extends from the day after the previous graduation when strong and weak spots are dissected and analyzed. By September things are rolling: plants must be potted and grown (600 pots of these flowers, 400 of those, 200 of another, explains Mary Morrissey, the executive secretary of the Commencement Committee). Child care arrangements (children whose parents want to attend Commencement are taken on trips or to M.I.T. activities, according to age groups), music, key figures in the proceedings, letters, backups, just in case . . .

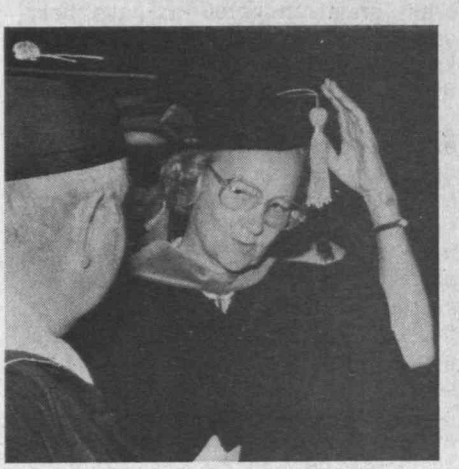
What goes wrong this year could be something that went right for 15 years, explains Ms. Morrissey, who's been a major force behind the event for just that long.

"I must make sure everyone understands his or her role," she explains. She's with them before the procession starts—often some item is missing. Someone forgot what to do. She attends to last minute details, reassuring, spreading confidence. Will all the chairs be filled? Is someone present who is slated to speak? If not, where is the substitute?

"As with any big event, you must let it go," she says."You have no control over it. Things go wrong; that's what I'm here for. It could be some fluke—but everyone is so practiced and caring—we catch it, like putting out a fire. We had problems with the communication systems because of the rain; we just had to keep working with it. And keep calm. Don't panic. You must give the appearance of everything under control; if you panic, everyone else does. Surround yourself with the right people—then if something goes wrong, they take off to handle it," she explains.

What If It Rains?

The weather never matters. On Commencement day, the decision is made at 6 a.m. to hold (or not to hold) the proceedings in the court. "It would have to be pretty bad to cancel," says Ms. Mor-



How they took to their academic regalia: Angus N. MacDonald, '46 (top), as chief marshal—with confidence; Katherine Graham (with President Gray, below) with a certain diffidence.

rissey. "We have raincoats ready to distribute, we'd hold an umbrella over the speaker. We would do everything. The audience will take everything in stride. These people waited a long time to see this—they're not about to miss it."

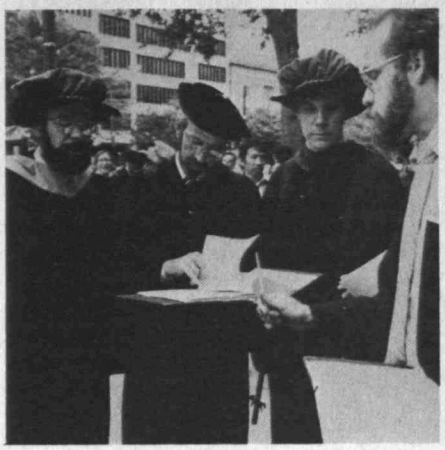
Bending Toward Peace

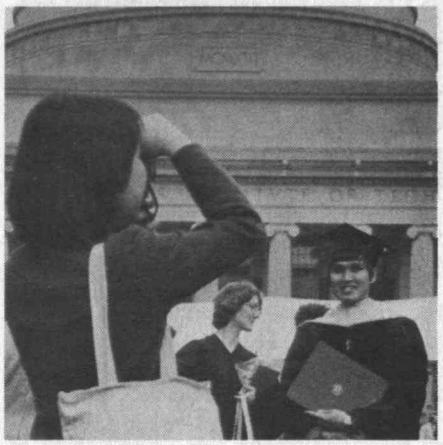
What they see is a loved one being honored. They can join in the day and share in the occasion. President Paul Gray, '54, in his charge to the graduates, voices their parents' thoughts:

"This is your time. The future is created every moment, by your decisions and actions in your public and private lives. What the future holds for this generation and for the generations that follow is, in large measure, your responsibility.

". . . I earnestly suggest to you that each of us must strive to help build nations and a world in which resources and energy and creativity are bent toward peaceful and humane use: to the nurturing of children, to the health and well-being and fulfillment of citizens. That is what it means to be a citizen of the world. And that is the challenge I set before you today."—*M.L.*

Katherine Graham on Watergate, Investigative Reporting, and the Role of the Press





The following is the text of the address by Katherine Graham, chairman and chief executive officer of the Washington Post Co., at the M.I.T. Commencement Exercises on Tuesday, June 1:

I am greatly honored to have been asked to address this graduating class. I am also somewhat intimidated to learn that I am the first outside speaker to have addressed an M.I.T. graduation exercise in nearly 20 years. I hope you didn't have such a bad experience with the last one that you suspended all invitations for the next 20 years and—even more fervently—I hope that nothing I say today will cause you to suspend invitations once more for 20 years. To this end, I shall try to be circumspect and prudent. I shall talk only about noncontroversial subjects like Watergate, investigative reporting and the role of an endemically unmanageable press in an increasingly hostile and out-of-patience potitical environment.

Let me begin with a story.

One weekend morning, ten years ago this June, I received a telephone call at my home. It was the managing editor of *The Washington Post*. He told me that our reporters were at work on two rather odd stories. One was about a driver who had lost control of his car. The car had crashed into a house . . . passed through a living room where two people were amorously engaged on a couch . . . and, to their understandable astonishment, sped on past and crashed through to the far side of the dwelling, right through the wall.

The other, rather less exotic, though still quite strange, story, involved five comic-opera type burglars who—decked out in surgical gloves, walkie-talkies and comparable gear—had been caught in mid-robbery at the headquarters of the Democratic Party in the Watergate buildings.

Well, I said, we certainly did have an offbeat paper coming up. Was there any *serious* news? As a matter of fact, there was, and today as the tenth anniversary of the Watergate burglary nears, we have been witnessing a national surge of analysis and retrospection. I would like to share with you my own preliminary thoughts on the questions of tenth anniversary concern: What is different in our country because of Watergate? Are things better as a result of it, or worse? Primarily, my observations will of course concern the press and its relationship to the government in particular and the society in general. But I can't help thinking that there will be a certain resonance in my remarks for people such as yourselves who have been part of an institution widely renowned as a great center of scientific learning. That is because on some particular points having to do with the mystiques of our chosen fields, our attitudes toward the free exchange of information and our sense of the distinctive obligations that go with our two professions, there is much common ground. We get into many of the same fights—with many of the same people.

Destructively Cynical?

The scientist, for example, is frequently resented for the discomfort, even danger, his successful enterprises create for other people. And so are we.

The most widespread accusation against the American press just now, and in fact, is that, in the aftermath of Watergate and our own presumptive success, we have become destructively cynical and disrespectful of all authority, unrestrained and reckless in our assaults on public figures who were merely trying to get the public business done. I will concede that in the first years following the conclusion of the affair, with the exit of Richard Nixon from office, there was a strain of this in the journalistic air, some reporters' confusing personal rudeness with investigative journalism, or focussing on the embarrassing trivia of their subjects' lives. But I believe that trend is now, mercifully, much muted, pretty well gone. It arose *partially* from the lack of professional understanding on the part of many young people of investigative reporting and the discipline it involves. As distinct from the *hectoring* that passed for a time as tough reporting, there is, in fact, a newfound and legitimate adversary vigor on the part of the American press. And one can only understand its value, I think, in the larger context of our peculiar national history.

We come from a long line of authority-challengers.

For almost as soon as there was an American president, there was someone going after him in print. By 1800, James Thompson Callendar had set out to show in a prodigious work what he called "the multiple corruptions of the federal government, and more essentially, the misconduct of the President, Mr. Adams." It was not so many years later that another of our presidents, Andrew Jackson, was to complain: "Mrs. Jackson is not spared, and my pious mother, nearly 50 years in the tomb, and who from her cradle to her death, had not a speck upon her character, had been dragged forth . . . and held to public scorn as a prostitute. I am branded with every crime."

The combative nature of the political commentators and even reporters in the country was reflected in the news columns of *The Washington Post* of the mid-19th century—well before my family had anything to do with it, I might add. The paper routinely referred in its news columns to President Rutherford B. Hayes, as, quote, "His Fraudulency."

What I am saying is not merely that it used to be worse and that we are quite tame by historical standards today. More important, I am saying that there is a strong tradition of independent, irreverent journalism in our country, and that it was the fact that this had

been in abeyance so long before the sixties came along that was remarkable—not its overdue resurgence.

The time I refer to here is the time of my own generation—the depression years, the World War II years, the War in Korea and the Cold War years. I think it is safe to say that even though there was a great deal of political dispute and bitterness about our government all through those decades, much of the American press, especially the press based in Washington, had come to think of itself, unnaturally, as *part* of the establishment. We saw ourselves as part of the economic recovery effort, part of the war effort, responsible adjuncts of a government that was trying to stop the marauding advance of Stalinism in Eastern Europe, trying to hold the line for western liberal values. Yes, of course, there were good, solid, independent newsmen and women throughout those years. But it was different. It was cozier. You didn't question as much or at least as fundamentally the motives or veracity of the governmnet of your own country. We behaved then the way the 1982 government wishes we would behave now.

But the results were not edifying. Sometimes it was the press' complaisant printing, without reservation, the outrageous smears and charges of Senator Joseph McCarthy against innocent victims. Sometimes it was its winking at evidence of congressional corruption and hypocrisy. Sometimes its acceptance of misleading statements concerning our so-called progress in the Vietnam war. Sometimes its tacit agreement to stay far away from covert intelligence operations and other national security adventures that even had our country repeatedly trying to murder political leaders abroad. But whether it was any or all of these things, the press was being the opposite of faithful to its tradtional cantankerous, disruptive American role. And I do not see how anyone could say that the resultant behavior of government was improved by our benign neglect.

Misunderstanding of Our Role

I know I am edging up to a danger line here—to that self-satisfied place where the press pronounces itself watchman, guardian, all that stands between an honest and a corrupt authority. This is an idea I reject. We are not police. We are not judges. We are not morally superior custodians of others. I am speaking only of a revivified sense of understanding of our role that emerged in the 60s and 70s, in relation to the war in Vietnam, as well as the multiple corruptions uncovered in Watergate.

That role is the subject of great misunderstanding. To some extent, it has

been grossly romanticized. In this, by the way, surely, the fearless, hardboiled, but lovable reporter of sentimental imagining shares a tinselly, unreal glory with the "Eureka, I've got it!" scientist of funny-paper provenance. "Eureka, I've got it!" is merely your version of "Hello, sweetheart, get me a rewrite"—or if you want an utterance that *nobody* ever says at all: "Stop the press!"

But romanticism is the least of it. A far greater misunderstadning of our role is that which sees us as prospective cheerleaders for majority opinion, or as handmaidens of established authority. People who see us this way are doomed to disappointment. For I don't think in our lifetime, we will see again an American press content to take the government handout, publish more or less what the established order wants published, and collude with it habitually and systematically to put out a version of the truth that officialdom has decided is the one fit for public consumption. That is past, dead and gone.

Here, I think, we come to a place where there is much common ground between the urgencies of science and the urgencies of the press. It is no surprise that it seems to be as laborious and delicate and (perhaps) defeating a job for the American Association for the Advancement of Science to create a code of ethics for scientists as it has been for the various councils and peer groups of journalism to come up with a suitable or acceptable code for us. We will not be told what we may print by official or quasi-official authorities. We will not respect, automatically, and on its say so, government's desire to keep secrets—greatly many more secrets, incidentally, than can by any stretch of imagination be held *legitimate* secrets and greatly more than even *are* secret at the time the government is quote "protecting" them.

I think back to a moment in the Pentagon Papers case, when the judge asked the government to say what *single* thing would damage American security, if it were to be published in *The Post*. The government attorney handed the judge a locked briefcase that had been sent over by the National Security Agency. It was all very dramatic. The judge unlocked the briefcase—this was in closed session—and he withdrew a manila envelope. Inside it was another envelope, sealed with red wax. He opened it, and the material inside made it clear that the United States had been monitoring the transmissions of a North Vietnamese radio station. The disclosure of this, the government contended, would alert the North Vietnamese to the fact that we were intercepting their radio signals—and eliminate a key source of intelligence. But as our defense correspondent was able to testify—to the government's great embarrassment—the fact that the U.S. government was monitoring this radio station had been made public at an open hearing of the Senate Foreign Relations Committee two years before. It was all part of the public record. This also proved to be a problem for the government in the Progressive case, if you recall: some of the material it was trying to protect turned out to have long since been made publicly available.

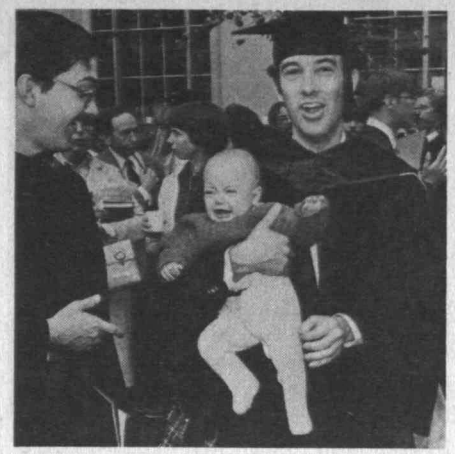
To say this is not to refute the government's position in that case that the recipe for a hydrogen weapon deserves the secrecy that was supposed to have enveloped it over the years. In fact, we at *The Washington Post* argued against publication at the time, believing that editorial discretion and restraint in certain kinds of matters, as decided upon and effected by ourselves—rather than being forced on us—go with the territory. Some journalists call this self-restraint censorship, which I do not believe it is, or disdain it as being "in the tank." However, I regard such exercise of judgment as the very essense of what we do and what we claim a privilege for.

Newspapers, after all, and magazines and broadcasts are by their very nature selective. And surely it can be reasonably argued that disclosure of such material as was in the Progressive account served no general informational purpose commensurate with the risk it was believed to entail.

The press, in fact, *often* declines to print certain information—in terrorist and hostage or domestic kidnap cases. And we have been known to withhold stories at government urging on what were called acute national security grounds—though again and again it has turned out that the forbidden subject matter was already widely known. Most often, however, our instinct is to print—to decide for ourselves and to publish.

A recollection is in order here.

One of the most widely quoted and also most widely misread statements of a government official in our country about the press was made by Dean



Rusk when he was Secretary of State. This was at a time when American involvement in the war in Vietnam had become the subject of raw and bitter conflict, and when the official account of our progress in that war had come under heavy questioning and suspicion on the part of the press. It was at a small informal press briefing with the elite of the Washington press corps—the columnists and bureau chiefs and editors—that Mr. Rusk, sorely pressed by a suspicious and disbelieving questioner snapped: "Whose side are you on?"

Although the session was supposed to have been "on background," meaning that this and other remarks would not be quoted, the agitation of the journalists present was such that the remark quickly got out. Needless to say, there was—and is to this day, when the subject comes up—a great commotion about it, about the fact, as it was charged, that the Secretary of State had cast doubt on the loyalty of the press, its very allegiance to the nation.

The Detached Questioner

This has always seemed to me rather to miss the point."Whose side are you on?" The question, in a brutal way, went right to the heart of a deliberate and unresolvable ambiguity that we in the American press have invited, have almost created for our public-private role. Of course, as citizens, we are on the side of our country. Just as we are, as citizens, on the side of our system of government and against domestic violence and criminality.

But we have also sought out a place for ourselves in a kind of no man's land, so far as loyalties and allegiances and obligations of citizenship go. We have insisted that it is not our role as journalists to promote the policies of our government, not our role to help the government succeed at what it is doing, not our role to save it from embarrassments, even when those embarrassments set back its initiatives, undermine its policies and its chances of doing well.

We have said that our independence as journalists has its own necessities. These shall, for example, prevent us from testifying as to certain criminal actions we may know about. If such testimony requires us to renege on assurance given to people who helped us get information, then their identity should not be revealed. As I said a moment ago, we have insisted on only the direst danger—say to the life of an intelligence agent, or a person held hostage by terrorists—as reason to cooperate with government in the sense of withholding information that it feels would be damaging to current policy. We habitually decline to withhold some things and publish others for the sake of bolstering, say, the economic recovery or public confidence in the government or public support of a national purpose.

The conscientious journalist in our country must continually be asking himself or herself where private citizenship begins and ends, and where journalistic imperatives take over. "Whose side are you on?" in fact, is a question quite *apt* to ask us, as it is one we ourselves have to answer all the time. It is we, not the government, who have chosen to assert this role for the journalist, that of the detached and disinterested questioner, the devil's advocate in some situations, or the one who reveals the information, be it helpful or hurtful to the cause, and lets the others make their judgment of it. How anybody can expect this to be easy or comfortable or accident-free, is beyond me. How anyone can expect even to be generally understood by his countrymen in such a role, let alone be loved for it, except when stories coincide with the interests of one or another group, is harder yet to grasp.

And is this so different from some of the problems you face? Who loves the scientists, after all, for their more devilish creations? Who will yield easily to them or to the claim that free exchange among their number and license to pursue their researches wherever they may lead have a crucial value to the society—national and international—in which we live? The scientist, too, asserts not just a special relationship to knowledge; the scientist also claims a special position, role and duty in the society, all transcending the ordinary limits and restraints of national citizenship. Both of us believe our line of business does not just *respond* to American humane values, but rather is an *integral aspect* of them. And we believe that it is precisely from our responsible exercise of the privilege—the freedom—we claim that the good we provide for society flows: a technologically advanced economy, health benefits, an informed and independent public.

Now this is getting pretty highflown, so I will bring it to an end. I will do so

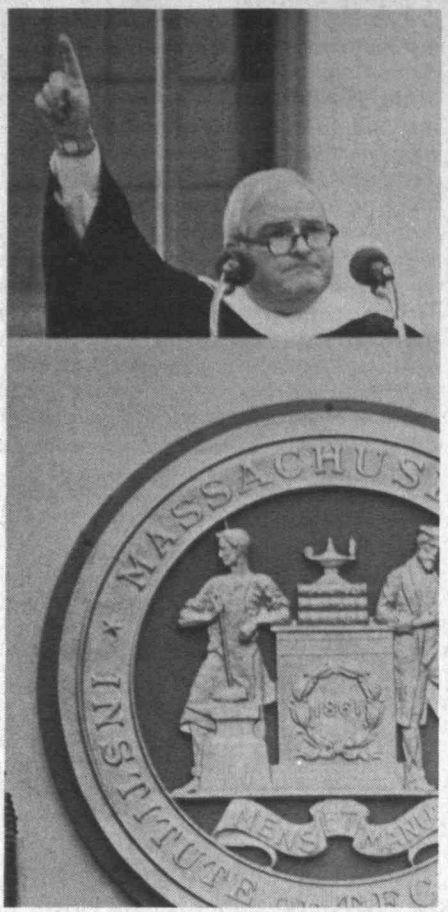
with another, slightly less scatological story than the one I began with.

When I was visiting an Eastern European country with some of my colleagues from *The Post* and *Newsweek* a few years ago, we were invited to the editorial offices of the local newspaper for an exchance of views and a little collegial chit chat. Our hosts kept pressing our supposed connection with each other as fellow journalists. And yet to us, this was bizarre. In fact, these fellows looked, and talked, as if they were the local Politburo; they readily acknowledged that they were in the business of pushing government and party propaganda and even claimed some authority to force government bureaucracies to act on their complaints within a given number of days. I wish some of the antagonists of our press freedom in this country could have been there. It was a chance for them to have seen the future—if they had their way—and exactly how it might work. Soviet prisons and mental hospitals provide evidence, too, of how the independent, inquiring dissident scientist, or other intellectuals, may fare when the interests of the State are considered paramount and overriding of all else.

In all too many parts of the world, I fear, it is like that. The idea of unencumbered, free and contentious journalism is a joke, just as an unfettered, productive, imaginative life of the mind is a joke. But they are not jokes in this country. They present an ordeal, maybe, for those who must put up with our pressing and pushing and provoking, our infuriating habits as disturbers of the peace and the status quo. But I regard the spirit that animates this troublesome activity as one of the glories of a democratic heritage. I know that you who are graduating today from this institution, known for its scholarly scruples and independence of mind, will carry this heritage forward.

Thank you—and congratulations on your graduation from so distinguished a university as M.I.T.

Paul Gray on What It Means to Be From M.I.T.



The following is the text of the charge to the graduates delivered by President Paul E. Gray, '54, at the Commencement Exercises on Tuesday, June 1:

In a certain sense you are about to come into your time as you leave these halls. You entered M.I.T. as citizens of your respective towns and countries—shaped by cultures, languages, and customs as varied as they are powerful. These are your roots.

As you leave M.I.T.—as most of you do now—you leave as citizens of the world. Your powers are great. And so are your responsibilities. What does it mean to be a *from*—or rather *of*—M.I.T.? And what does it mean to be a citizen of the world?

To be of M.I.T. means to have tapped the mysteries and tasted the potential of science and technology, no matter what your field of study. To be of M.I.T. means to have power of analysis, rigor of mind, reservoirs of stamina, and, I hope, the wisdom to put these strengths to work for the common good.

And what of the world you now enter? The headlines in the press remind us daily—if indeed we need to be reminded—that we live in a world in which there seems to be no limit to the suffering which humans cause their fellows—to the inhumanity manifest in human actions. . . . a world where hunger is not a specter but a fact of life—and death—for people in most nations. . . . a world where the threat—or worse yet, the use—of deadly force produces waste in awesome and tragic dimensions.

Consider: Two major nations have gone to war over a cluster of islands in the South Atlantic. Once again the old have sent the young to fight and die in a conflict which might have been resolved by economic pressure, by diplomacy, or by judicial means.

Consider: In the Mideast, Iran and Iraq—and Israel and the Palestinians—continue to throw away thousands of lives in protracted and furious struggles which threatens to unsettle the Middle East.

Consider: The efforts of the people of Poland to achieve a measure of freedom and self-determination have been brutally crushed by a totalitarian government which claims its philosophical roots in the aspirations of the working class.

Consider: Our own president talks of arms limitations while pressing for the development of new and redundant nuclear weapons systems—systems which drive the defense budget beyond the size of the *entire* federal budget just a few years ago. At the same time, funding for education and for human services continues to shrink.

Each of you can expand this list; there is no shortage of examples.

I am not suggesting that conflicts of national interest will not arise in the future or that different peoples will not have different views regarding the use of scarce resources or the requirements for national survival. But I earnestly suggest to you that each of us must strive to help build nations and a world in which resources and energy and creativity are bent toward peaceful and humane use: to the nurturing of children, to the health, well-being, and fulfillment of all citizens.

That is what it means to be a citizen of the world. And that is the challenge I set before you today.

In your years here, you have acquired an understanding—even some mastery—of science and technology. You have been immersed in an international community. And—I hope—you have come to see that science and technology are not ends in themselves. They serve to stretch our imagination and our understanding of the world, and they *can* serve to make that world a better place.

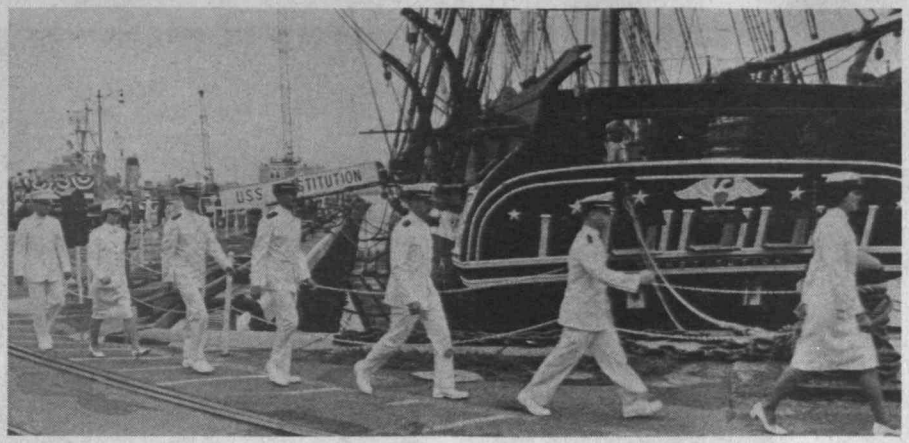
To do so, they must operate in a larger context—a context which recognizes and respects the international character of our social, political and physical environment, that reflects the needs and conditions of peoples everywhere, that recognizes that the future is now.

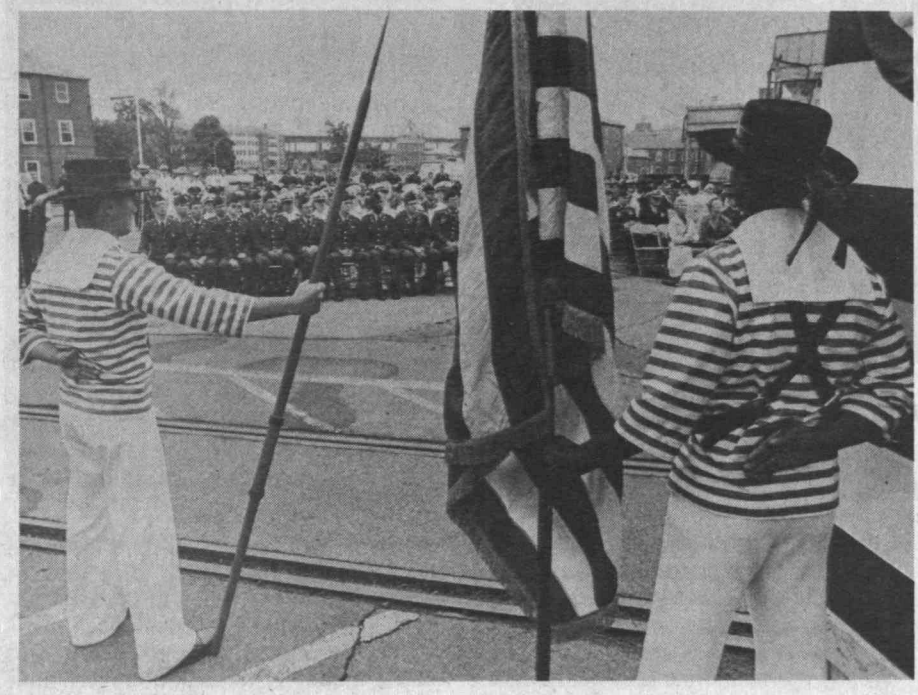
This is your time. The future is created by your every moment, by your decisions and actions in your public and private lives. What the future holds for this generation and for the generations that follow *is*, in large measure, your responsibility.

I am moved to share with you the vision of the poet Archibald MacLeish, a founding member of the M.I.T.'s Council for the Arts. His death this spring stilled his voice but not his message. Speaking to us here at M.I.T. a decade ago, he said:

"The world's real problem, as almost every new 'crisis' makes more obvious, is the humanizing of technology and science itself. This means, inescapably, the humanizing of the teaching of engineering and science in an education which, without diminishing the rigor of knowledge, will ultimately see the arts and sciences integrally, not separately—common means to a single end."

I hope that M.I.T. has instilled in you an increased consciousness of the "single end." Today, as you leave this special place, I wish, for each of you strength of will, wisdom, and Godspeed.





Fifty-two M.I.T. ROTC cadets received commissions in the Army, Navy, Air Force, and Coast Guard aboard the U.S.S. Constitution in Boston Harbor on May 31. The colorful ceremonies were guarded by members of "Old Ironsides' " complement, with commissions bestowed by the principal speaker, Admiral Robert L. J. Long, commander in chief, Pacific. (Photos: Calvin Campbell)

Sustained Alumni Performance

The $4,000 Grand Award for Sustained Performance in Annual Giving has come to the M.I.T. Alumni Fund from the Council for the Advancement and Support of Education. The award, funded by the U.S. Steel Foundation, recognizes the increased contributions and contributors to the M.I.T. Alumni Fund over the three-year period from 1979 to 1981; it was given to Joseph S. Collins, director of the fund, during CASE's annual meeting in Detroit in July.

In receiving the prize, Mr. Collins noted that the award in fact "reflects the generosity of M.I.T. alumni," and he paid tribute to "the dedicated efforts of alumni volunteers." The $4,000 grant, he said, would become "a symbolic first contribution to the 1983 Alumni Fund."

Class Gift For War Memorial

A contribution of more than $4,100 is the largest amount ever raised for a senior class gift at M.I.T.. It will be used to memorialize 18 M.I.T. alumni who gave thier lives in the service of their country in Korea and Vietnam and "humanize" the lobby where their names—and those of M.I.T. alumni killed in two World Wars—are displayed. The names (8 from the Korean war and 10 from the war in Vietnam) will be engraved on two marble columns in the lobby of the Maclaurin Building (Building 10), and there will be new furniture for the lobby: benches, tables and planters.

The amount contributed by the Class of 1982 was raised to more than $10,000 by a matching gift arrangement with the 50th reunion class of 1932. In addition, members of the Class of 1982 pledged to give a total of over $17,000 to the Alumni Fund over the next four years.

Charles Frankel, senior class president, says the memorial is "a timely gift. It serves to remind us that war is real and people die—that war should be avoided at all costs."

Johnson to Retire as Chairman; a Selection Committee is Named

Howard W. Johnson will retire as chairman of the Corporation on June 30, 1983, after 12 years in that post. His future plans are unannounced; he just thinks that 17 years—12 years as chairman following five years as president of M.I.T.—is long enough, he says.

Mr. Johnson is 60, and he's been at M.I.T. since 1955, when he came to be associate professor of management and director of the Sloan Fellowship Program. Four years later he became dean of the Sloan School and in 1966 succeeded Julius A. Stratton, '23, as president.

Through those years, says President Paul E. Gray, '54, Mr. Johnson's "impact on the quality, vigor, and strength of M.I.T. has been enormous. He is one of the great M.I.T. leaders," Dr. Gray said; "his accomplishments have been a source of inspiration to us all, and his contributions have shaped significantly the character and stature of M.I.T."

An ad hoc committee to recommend a successor as chairman has been chosen from members of the Corporation, with Carl M. Mueller, '41, senior member of the Corporation's Executive Committee, as chairman; serving with him are Angus N. MacDonald, '46, and Emily V. Wade, '45.

A

B

What Good in Basic Research? Bruce Old Tries a New Method and Gets a Big Answer

Since World War II the U.S. has invested countless billions in basic research. Was it worthwhile? What return has the nation harvested from this prodigious investment?

No one knows.

Seeking an answer, Bruce S. Old, Sc.D.'38, former senior vice-president of Arthur D. Little, Inc., who is now president of Bruce S. Old Associates, Inc., Concord, Mass., in 1980 arbitrarily selected three of the first basic research projects ever funded by the Office of Naval Research for detailed study: if the benefits of these three projects could be measured, then the anecdotal research format chosen by Dr. Old could be proved and perhaps his results roughly extrapolated to give some sense of the fruits of 40 years of government sponsored basic research in the U.S.

Dr. Old's conclusion, reported this spring in *The Bridge* of the National Academy of Engineering: "overwhelming" verification of the original idea that basic research funding by the Office of Naval Research would strenghten the nation's military effort and—by implication, strong evidence that government-sponsored basic research is an investment almost without equal for the country's industrial prosperity. Among Dr. Old's conclusions:

☐ Support of basic research initiates a "giant chain reaction": students trained under one grant go forth throughout the country to apply their knowledge and to train more students.

☐ Only rarely is it possible to trace directly the economic returns; more often, the unquantifiable problem is to estimate "the worth to society of a professional trained person and his career contributions."

☐ Research paybacks occur over long periods, often extending beyond the tenure of the federal administration which had the foresight to make the original investment.

In sum, says Dr. Old, the early basic research investments yielded "a flood of knowledge and practical accomplishments" which might otherwise have never been attained at all.

The Feedback of High Technology

In his keynote address to the 1982 Electro conference in Boston, Ray Stata, '57 president of Analog Devices, Inc., emphasized a very similar message: the flowering of high technology in America, he said, is the "unforeseen" result of the nation's efforts in the 1950s to find new basic technology for national defense and space. National economic growth wasn't part of the plan at all, said Mr. Stata.

Now the U.S. is taking its success for granted. "We forget," he told his Electro audience, "that much of growth in the 1970s can be traced to the very significant investment in technical manpower resources in the 1950s and 1960s largely as a result of government spending."

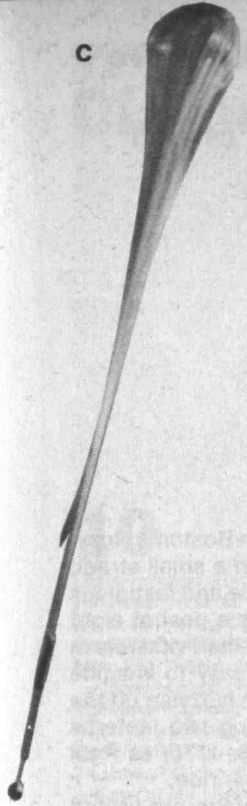
Despite his year-long study, Dr. Old says he has barely scratched the surface. He concludes that few scientists have ever turned their attention to themselves and their colleagues seeking to understand the effect of their work on socioeconomic growth. And, he concludes, the whole subject of returns on government investments in basic research remains "a fertile area for further study."

Royalities, Profits, Prizes, and Professors

Because it was nearby and because it was a pioneer in government-funded basic research, Dr. Old chose M.I.T. for his research. The three projects, all sponsored by the Office of Naval Research:

☐ Project Whirlwind, orginally aimed at developing high-speed computer systems for use in an aircraft trainer-simulator.

☐ The Laboratory for Nuclear Science and Engineering, a multidisciplinary basic research group in high-energy phys-



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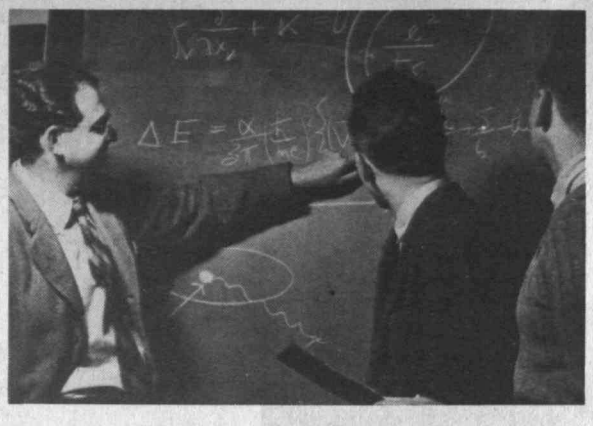

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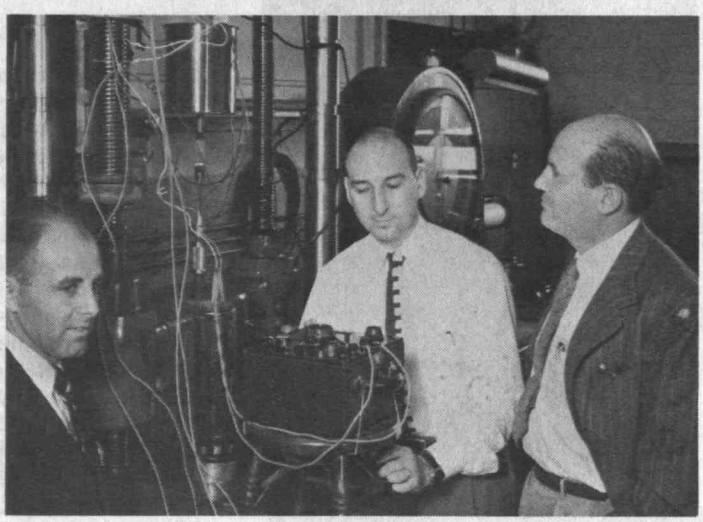

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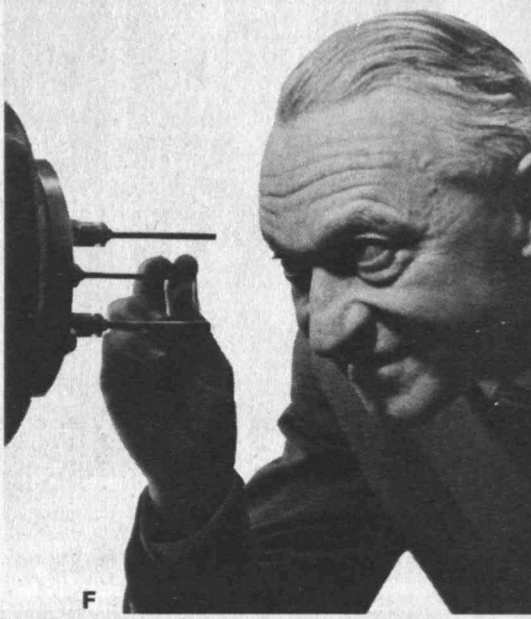


F

ics and its applications.

☐ Metallurgical science and materials policy research by Professor Morris Cohen, '33, a member of the metallurgy (now materials science and engineering) faculty since 1934, and his students.

In briefest summary, here are Dr. Old's findings in each case:

Project Whirlwind rapidly outgrew its original mission and became a basic research project on high-speed computation systems. From it came a whole new technology of air defense: the magnetic core memories which dominated computer design for 15 years from 1958 to 1973, the development of numerically controlled tools as forerunners of computer-aided design and manufacturing, the concept of computer time-sharing, and more. Magnetic-core-memory royalties to M.I.T. alone were $25 million. Only one of the many new companies founded by Whirlwind workers—Digital Equipment Corp.—has paid $600 million in corporate income taxes since its founding. According to Dr. Old's figures, that's more than 30 times the goverment's original grants to be entire Whirlwind projects. "... a truly amazing series of paybacks," says Dr. Old.

Between its founding in 1945 and the withdrawal of support by the Office of Naval Research in 1958, the Laboratory for Nuclear Science and Engineering received some $14 million of ONR funds. A total of some 400 staff and students participated during this 13-year period; of these:

☐ Three have won Nobel prizes.

☐ Twenty-one have been elected to the National Academy of Sciences.

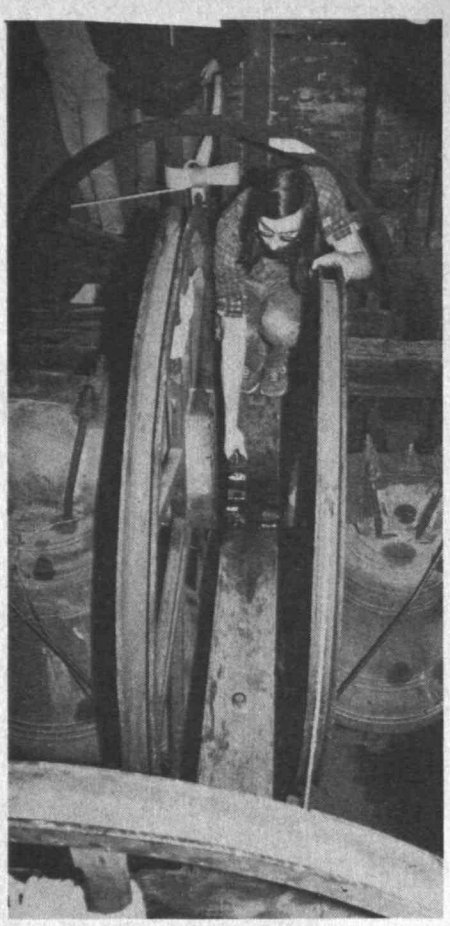
☐ Nine have been elected to the National Academy of Engineering.

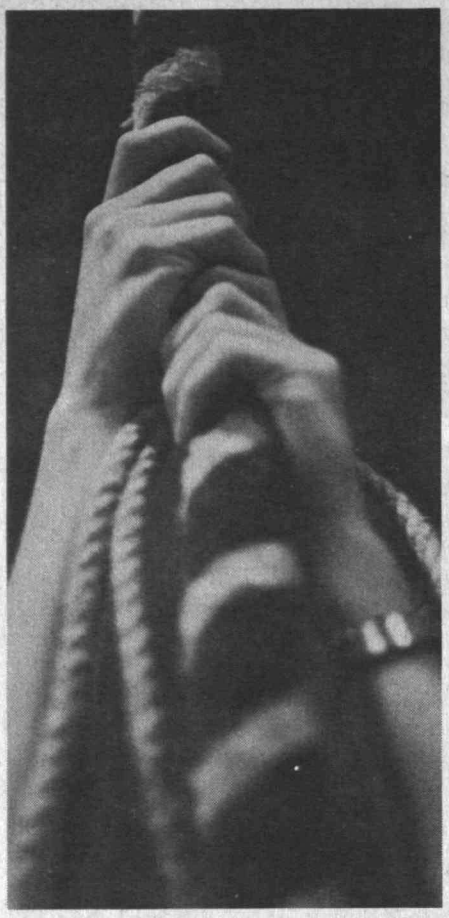
☐ Over 110 have become professors in some 56 universities.

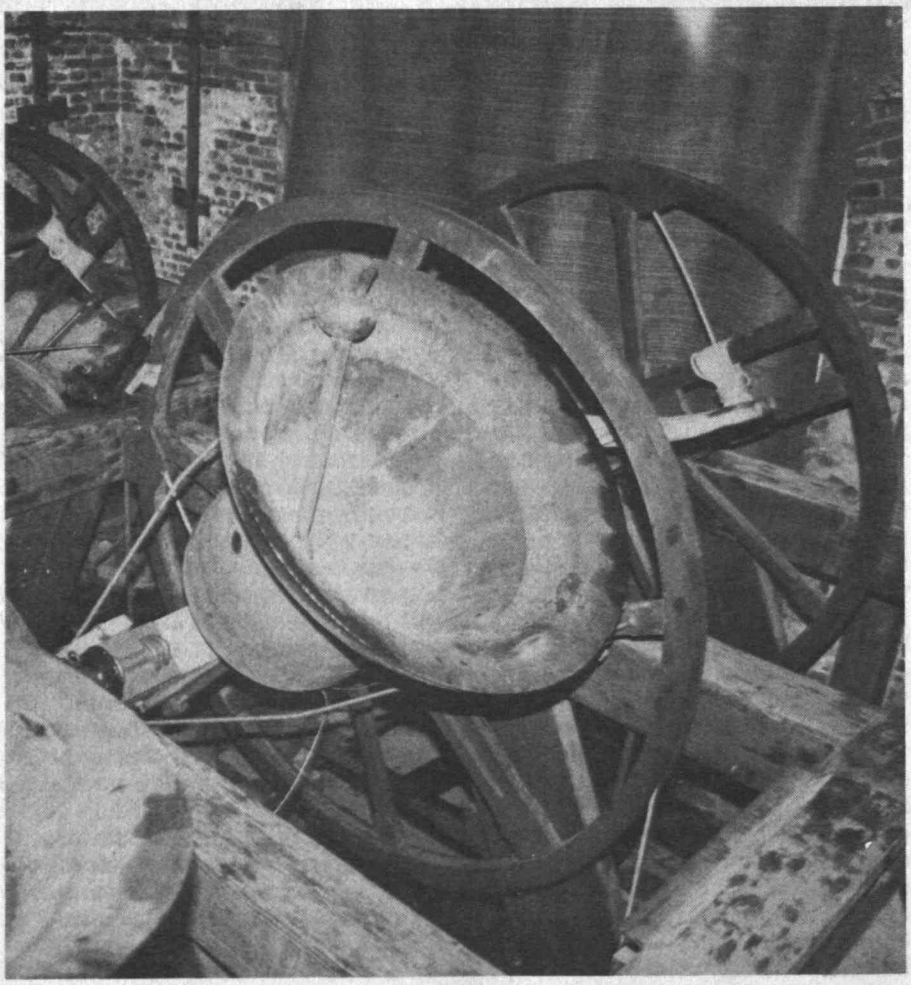
☐ Over 100 have become officials in 74 corporations in many sectors of industry. Yet Dr. Old proposes that "the true returns from the LNS&E investment are just in the beginning stages."

Since 1947 Professor Cohen has had a succession of 40 graduate students funded by ONR at a total cost of $1.6 million. In addition to the 40 theses, there have been 98 professional papers which have won 15 medals and awards and been associated with 15 honorary lecturships. After studying the careers of 19 of Professor Cohen's students, Dr. Old finds that they have published over 900 professional papers. They have "contributed substantially" to many emerging fields of materials science and policy, he writes; futhermore, many now have their own sets of new students. In all, the work has had "a substantial impact on the materials posture of the United States through the new knowledge created and the people trained," writes Dr. Old.

Three M.I.T. research programs of the 1950s are the basis of the conclusion by Bruce S. Old, Sc.D.'38, that basic research is "an investment almost without equal" in assuring future industrial prosperity.
***A**—Whirlwind. Professor Jay W. Forrester, S.M.'45, with the magnetic core memory developed for this pioneering computer. The patent on this device alone has returned to M.I.T. some $25 million.*
***B**—Laboratory for Nuclear Science and Engineering. Professor Jerrold R. Zacharias and graduate student Richard D. Houn with the "atomic clock," the "world's most accurate timepiece."*
***C**—Laboratory for Nuclear Science and Engineering. America's first spacecraft: cosmic ray detectors carried aloft by balloon.*
***D**—Laboratory for Nuclear Science and Engineering. Professor Victor F. Weisskopf with graduate students in the laboratory's theoretical group.*
***E**—Metallurgy and materials policy. Professor Morris Cohen, '33 (right) with Professor Benjamin L. Averbach, Sc.D.'47, and graduate student S. Andrew Kulin, '49, at work on low-temperature hardening of steel.*
***F**—Laboratory for Nuclear Science and Engineering. Professor Bruno B. Rossi scana a cosmic-ray cloud chamber. (All photos: M.I.T. Museum—Historical Collections)*







Following Paul Revere's Footsteps Into the Belfry of Old North Church

"One if by land,
Two if by sea . . ."

The Old North Church in Boston's North End stands modestly on a small street; its charming brick facade and fastidious pointed steeple shelters a peal of eight bells that give no hint of their vital role in American history. It is easy to imagine Sexton Robert Newman hurrying up the narrow staircase to hang two lanterns on the night of April 18, 1775, as Paul Revere began his famous ride.

Today these same stairs are visited twice every week by members of the M.I.T. Guild of Change Ringers (an interchangeable band of 20 or so people) who ring the bells in practice on Saturdays and for services on Sunday mornings.

"Change ringing is the only time a tower bell is swung *all* the way round in a full circle (the note is heard when the bell mouth is horizontal and the clapper hits)," explains Arthur Lewbel, a graduate student in management. "It takes moderate strength (although a small person can do it), with good control, and timing," he says. Each bell has its own note; it's difficult to achieve the precise rhythm so that each bell can clearly be heard in the complete instrument. "The music consists not of tunes, but sequences of notes. Some compare it to modern music," he adds, "but it's centuries old."

Professor Geoffrey Davies of Northeastern University, an avid change ringer and history buff who was instrumental in starting the M.I.T. Guild, explains further: "It takes three hours to ring a full 'peal'. A 'peal' consists of ringing over 5,000 different 'changes' or rows, where a change consists of each bell being rung once to make a sequence like 75312468." Despite their age, Professor Davies told me, the bells of the Old North Church had never been made to ring a full peal until this past New Year's Eve. The feat takes a good deal of mental concentration and physical stamina on the part of the ringers, and four of the eight participants of this first peal were M.I.T. students or alumni.

Normally the M.I.T. Guild of Change Ringers assignment is much shorter—a

Classes

10

I have received a nice note from **Harold E. Akerly**. He writes: "After 66 years of happy marriage I am alone. But I am grateful for health and, when needed, strong support from my family." God bless you, Harold, and thanks for writing.

I have received notice of the death of **George S. Thomas** on January 11, 1981. At the time of his death he was living at Carroll Health Center in Carroll, Iowa. His son's address is George W. Thomas, P.O. Box 613, Carroll, Iowa.

If any of our classmates attended this year's Technology Day, please write and tell us about it.—**Fred R. Lufkin**, Acting Secretary, 24 Linden St., Portland, ME 04103

13 70th Reunion

We saved a few letters in response to my December appeal, so there would be notes for this month.

First, I wonder if any '13ers attended any part of Technology Day. Please let me know.

Allen Brewer sent us some poems and as Father's Day is near (at this writing), this seems appropriate:

Down through the ages mothers
have been justifiably honored,
From orange blossom weddings
they've earned maternal right.
'Tis only fair that this should be,
but don't forget the boys
Without whom you and I could never
have been brought to light.
The patrefamilias they were called,
in days of ancient Rome;
They found caves, they built the huts,
today the fabled cottages,
Where they and mothers raised their broods
'gainst natures fearsome ravages.
So to you, fathers of the clans,
Today we pay you tribute;
With mothers you have earned our love,
We give you hand salute."

Allen also says that he "in-a-way misses the snow and the joys (?) of shoveling out the driveway."

C. Lalor Burdick continues to have a very active life. He writes: "I retired from the duPont Co. in 1957 and took over the active directorship of the Lalor Foundation. This is a small research foundation founded in 1934 and IRS approved. The awards granted have been in strictly limited fields in science and education. I am an active emeritus trustee of the University of Delaware Research Foundation, and I am currently working on the Campaign Funding Committee for the Delaware League for Planned Parenthood, which must build new quarters. We have two children. Lalor, my son, has the title of vice-president for investments with the Boston firm of Scudder, Stevens, and Clark. He has two sons, Christopher (9) and William (5). My daughter, Cynthia, lives in Providence, R.I., with her daughter Morgan (15) and son Andrew (12). Cynthia works hard as auxiliary president of the Women's and Infants' Hospital there. She is also a member of the board of governors of the Westover School.

"A little over a year ago, Mrs. Burdick and I lessened our burdens and cares by selling our 130-year-old country home, built in the Greek Revival period and style, and building ourselves a suburban cottage. I had lived in the old house for 50 years. My opinion of the world today is there is such a loss of ideals. Until honesty, patriotism, and some unselfishness are restored, the world will continue to disintegrate. That is why we are putting our efforts into supporting Mount Vernon, which seems to us to embody the essence of these values."

Thomas J. Lough always writes an interesting note: "I have no personal news of sufficient importance to qualify for inclusion in the class notes. I am retired (although holding the honorary position of consultant with my company). I am living with my daughter and her husband. I am over 92 years old, possibly the oldest surviving member of my 1913 class. I have two children, eight grandchildren and two great-grandchildren (none of whom, unhappily, attended M.I.T. Too expensive, it was claimed). As to the world today, it is becoming socialist (recently witness France and Greece) including the U.S.A. with President Reagan making a valiant, but I fear futile, effort to return the country to its original free enterprise system."

I was delighted to receive a reply from **Herbert G. Shaw**, as it has been two years since he has written. We always enjoyed seeing Herb and his lovely wife, Leila, at all the reunions. He writes: "The only news we have is that we are glad we came here about three years ago. I brought my basement workshop, and I work there a little each day. The rest of the time we just loaf around and eat three good meals a day and put on extra weight. We see prime examples each day as to how we older people are taken very good care of. Who could ask for more? You asked for news of us. We would like to read some news about how you are doing. All of '13 love you and ask for news in the *Review* about you."

To answer Herb's question for news about me, all I can say is that I'm healthy. I keep busy doing volunteer work at our local library and delivering Meals-on-Wheels. I still have a vegetable garden, and I find it's increasingly difficult to keep it weed free. I have some great neighbors and friends and my constant companion, Ebony, my 3-year-old black dog. Like the song says, love makes the world go round. We should all share more of it.

More news next month. In the meantime, I hope you are enjoying the summer.—**Rosalind R. Capen**, Asst. Secretary and Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

14

Word came in May of the deaths of three of our classmates: **Frederick B. Barns**, in Burlingame, Calif., on November 23, 1979; **James W. Easter**, in Owings Mills, Md., on October 12, 1981; and **Harold A. Mayer**, in Milwaukie, Ore., on February 3, 1982. I hope to have accounts of their careers in later class notes.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

15

Many classmates have been looking for news, and as class agent, having just received acknowledgments from some of you, I am most anxious to share with you my first-hand information!

It is with deep regret that I must advise you of **Azel Mack's** passing away. He was so fond of each and every '15er, and his whole life and interest was indeed "1915, the Class Supreme." . . . **E. Ellis Ellicott, Jr.** had his 90th birthday celebration on March 20 and hastened a reply to me as he was taking off for a week in the Bahamas, hopefully to catch some fish. . . . **Charles Loring Hall** has really wanted to read about his classmates, and always writes. He announced that he and his wife were looking forward to the christening of their new great-grandson, Mathew Thayer Hall. . . . **Francis Hann** sent such a friendly letter. He is a retired lawyer and enjoying life, that's for sure. He has a great sense of humor, included some jokes, and put on his envelope: "Inflation is when the product for which you paid too much in January is a bargain in June."

Mary Plummer Rice (or Mimi, as she likes to be called) has traveled extensively. She reports that the best trip of her life was to China last September, with her son Pat. She had written to M.I.T. alumni living in China, and she and her son were entertained, dined, luncheoned, and receptioned. It was so wonderful to be so welcomed, she says, and it was a month of a lifetime. She also asked me to say hello to 1915 classmates for her. In mid-April she is going to Washington, on to Puerto Rico to visit her son, then for two weeks on a missionary ship arriving in San Juan in May for a couple of weeks, will finally return to attend an annual congress of the National Society of New England Women gathering in Vermont, and then back to New Jersey for a week with some of her family. A pretty busy gal, that's for sure. . . . **Robert (Bob) Welles**, of Pasadena, Calif. never fails to drop me a note. He is living with his daughter, anxiously waiting to pick the oranges and berries that will be ripe shortly—and peaches later on. He enjoys going for walks with his German shepherd, and now his daughter and her friend, Carlotta and Florence, came home with a seven-week-old boxer puppy which he is enjoying. Mentioned he is 91 and some months old! . . . **George Easter** spent last winter in Florida and last summer traveling to New Zealand and Australia—had a marvelous time. . . . **Ercell Teeson** sends his greetings to one and all. . . . It is fantastic how the '15ers have joined in the M.I.T. 1982 Alumni Fund, and more rewarding to have tidings. . . . Hope to hear from more so we can continue to carry on our "hot line."—**Joyce E. Brado**, Class Agent, 491 Davison Rd. No. 9, Lockport, NY 14094

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It has been 66 years since our graduation and some of us are still quite active. **Dina Coleman** travelled to Iceland in July. **Mickey Schur** planned to be in Europe this summer. Frances and **Paul Duff** travelled throughout the U.S. visiting their children and grandchildren last spring. Sibyl and **Ralph Fletcher** were in Switzerland in the early spring. In June, **Charlie Crosier** wrote that he was travelling south. Then we have our gardeners, **John Fairfield** and **Chet Richardson**, and our walkers, **Nat Warshaw** aand **Izzy Richmond**. **Hy Ullian** continues to be active in his business as does Ralph Fletcher. These are only a few of our classmates from whom we hear regularly. There are others from whom we do not hear who are probably doing as much or more. . . . Millie and **Charlie Reed** recently wrote: "We wish that we could be with you in Wakefield this year but our plans just don't allow time for a reunion." Charlie, Millie and their friend, Lansing Warren, attended our 65th last year and then Charlie and Millie headed for Maine for the summer.

Chet Richardson recently wrote us a newsy letter from which we quote: "First, we are sorry, disappointed and otherwise frustrated at not being able to take in next month's reunion, our 66th. Various things have come up to make our trip to M.I.T. not possible this year. We sure hope to have better luck in the future. I had planned to spend the Christmas Holidays with my son John and his family last December, and got out to Santa Rosa, California, on schedule December 16. The holidays went off very well, and things seemed ready for a normal return on January 16, when Jane, whom you remember is the daughter who came to the 65th with us, called up on the phone and told about sub-zero temperatures and 50 to 60 m.p.h. winds with chilll factors around -100 degrees, she said 'Stay awhile longer.' Believe it or not, this act repeated itself twice more. Finally, it was decided that February 15 was the return date, come H or high water. Then, on February 10, I had the first nosebleed of my life. It began so easily that my son had to call my attention to it, but it made up for the 86-year delay and put me in the hospital for five days. The doctor recommended no airplane trips for a while on account of the reduced pressure at flight height, so I did not get home until March 16. So when I got to the exit door of the plane, the hostess handed me over to a big six-foot plus policeman to escort me to the waiting room, holding me firmly by the arm. It took a few minutes for him to realize that not all 86-year olds had to be half carried down the ramp and into the waiting room. One of the things I remember about the trip is a remark my son John made casually. He said he would like to come back in June for a high school reunion at the Youngstown High School. Then he made me stop and think by saying, 'Next July I will be 50 years old.' I made some profane comments on how I had forgotten how time flies. I should have been prepared, because in the fall of 1980 I visited a nephew in Indiana, and he remarked he was 'approaching' 70. His father was my brother, 12 years older than I—M.I.T. '04."

We regret to report the passing of our classmate, **Frederick W. Childs**, on May 3, 1981. We received a letter from his wife telling of the 50 wonderful years they had together. . . . Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01863

17

Your acting secretary regrets very much the lack of notes in the April issue.

By the time you read this, our 65th Reunion will be history. It looks as though our number of classmates will be only 15, which according to records is about par for a 65th. Our total will be some 25. By now wives really qualify as classmates.

Howard Melvin supplies information about a meeting of the M.I.T. Club of Northern California held at the Greek consulate in San Francisco on April 2 which he attended with his daughter and her husband. After World War II the Economic Cooperation Administration (ECA) was established to assist restoration in Europe. The Ebasco Services, Inc., was selected to evaluate the electric service in Greece, Athens having practically the only electric system. Howard was chief consulting engineer at Ebasco, and the responsibility for the study and plans to implement a system for the entire nation was his. Ebasco was engaged to implement a five-year plan for a complete nationwide electric power system. This was all under Howard's supervision, necessitating residence in and numerous trips from Greece. The operation was dedicated in 1955 and continues today with a ten-fold increase. Howard, wearing his 50th year red jacket, was introduced by Chairman Achilles Adamantiades, Ph.D. '66. The hosts were the consul general of Greece, Mr. and Mrs. Botzios. Mr. Botzios greeted the group and gave an interesting talk, followed by a question-and-answer period.

Bill Sullivan writes regretting that he and his wife are unable to attend the 65th. He refers to a letter he had from **Ray Stevens** asking for some notes on his activities. The letter had come while Bill and his wife were spending nearly a year in the interior of China. Handling a year's mail accumulation proved too much. "I ran into secretarial problems. No one around here wants to work for a cantankerous old man who is apt to be here one day and gone the next."

In Newburyport, Mass., in Lord Timothy Dexter Industrial Park, one finds Mulliken Way. There were forerunners by that name, and an article in the October 1981 issue of *Nucleus* under "Historical Notes" mentions two of particular interest to us. One is Samuel P. Mulliken '87, professor of organic chemistry and the other is **Robert S. Mulliken**, winner of the Nobel Prize in 1966 for his work in the theory of molecular structure and spectra. Interestingly, both men were helped by scholarships from the Wheelwright Scientific Fund which still helps Newburyport residents seeking a scientific education.

According to the *Nucleus* article, Robert Mulliken earned his Ph.D. from the University of Chicago, and later joined that faculty. His career is marked with many honors, starting with extensive correspondence with European scientists. In 1929, he received a Guggenheim Award, and continued his work on halogen molecular spectra. His most recent published work is "Computer Calculations in Molecules." He confesses to be excited by the work in computers and says that he "approaches working with computers in the same way the Greeks used to approach the Delphi oracle: in fear and trembling of what it will tell me but looking forward to it."

With regret the deaths are recorded of **David M. Jones** on February 14, 1973, at Schenectady, N.Y., and **Benjamin Levy** on February 10 at New York City.—**Stanley C. Dunning**, Acting Secretary, 33 Christian Ave., Box 218, Concord, NH 03301

18

As is usual this time of year (May), class notes are lean. I am most grateful to **Paul McGreenery** for his newsy report. He writes, "In answer to your inquiry about how M.I.T. influenced my career, that is quite a question. I wish that I could think of something profound to say. After a hitch in the Navy in World War I, I located a job in New Hampshire and was away from this area for about ten years, so my contact with M.I.T. was zero. Tech got me the job in New Hampshire, and as jobs were scarce, the $30 a week looked good, even after a ten percent pay cut within three months. I stayed with the company for 46 years and, despite ups and downs, was quite contented. I feel that the greatest benefit I received from my association at M.I.T. was the feeling that came to me from the teachers and also from my classmates—of that quiet self-assurance that there is a best answer to every problem and that a persistence to that end will pay off. I just received a bit of news that gave me quite a thrill. My grandson Mark is graduating from the University of New Hampshire this year and is applying for entrance to the graduate school of M.I.T. this coming fall. With no prodding from me, he has made his own decision to try for M.I.T. It would be quite satisfactory to me if he made it. Imagine me having a grandson at M.I.T."

Plans are already being made for our 65th Reunion in 1983. I made the suggestion that all M.I.T. alumni of the classes senior to us returning in June 1983 for Technology Day join us in our celebration. It will make those who return to Cambridge from the classes preceding ours feel at home with a most cordial welcome. Hopefully, this reunion for all out more than 65 years will start a precedent that will become a tradition.

It is with sadness that I report that **Rolfe Folsom** died very suddenly on May 5. His wife Doris, of 1156 Grimley Lane, San Jose, CA 95120, writes: "He had always hoped to go quickly when his time came, and he did, but we had not thought it would be now, for he has always been so well. He couldn't wait for our 63rd wedding anniversary. He always used the training received at M.I.T., although not along the line he had trained for. He had a long and happy life, but left much too soon." We are grateful to Doris for sending this news and extend to her the sympathies of the class.—**Max Seltzer**, Secretary, 1143 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

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The current mail brings your class secretary notice of the deaths of three more M.I.T. '19 classmates: **Paul W. Blye, Robert S. Bolan**, and **Max Knobel**. Always at such notices I become reflective and recall our student days' associations on Rogers Steps and other gathering places, the corridor trips between classrooms and lecture halls, and then finally the sudden departure for service in the war of the day. Now after many years, I read of how some of these students spent the rest of their lives meeting challenges and solving problems, and I feel a sense of pride that I was once closely associated with them in their formative years. And so it is with these three classmates whose passing I must note. Each of them is a credit to M.I.T. and our class. Each performed creditably and notedly in their profession and in service to their communities, and so I hope you, too, are as proud of them as I am.

D. Arthur Lundquist thoughtfully sent me a card with his new address: 700 Mease Plaza, Apt. 927, Dunedin, FL 33528. . . . **Don Way** and I, together with our wives, attended a luncheon with other North Jersey M.I.T. men at the invitation of Jerry Cook, '3l. There Hugh Darden from the Institute described several life income plans and particularly the newly established Maclaurin Pooled Income Fund which has some special tax advantages. Any interested classmate can obtain literature and further information from the Office of Planned Giving, Room 10-282, M.I.T. Our class president has accepted the resignation for personal reasons of **Russell S. Palmer** as one of our class agents. Way is working on a replacement.

A nice note from **George Michelson** to advise that he is still active, goes to his office in Boston every day, and enjoys reasonable activity in his community interests. . . . Keep in mind our next class reunion in 1984, and plan as best you can to attend. I hope many of us will make it at least one more time.—**Bill Langille**, Secretary, Box 144, Gladstone, NJ 07934

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An unexpected favorable showing for the good Class of '20 turned up at the very pleasant gathering of old timers at Endicott House in Dedham last spring. Present were Mary and **Henry Hills**, Mary and **Henry Massey**, Hannah and **Harry Kahn**,

Mina and **Perk Bugbee** and Amy and **Harold Bugbee**. Those present enjoyed the lovely spring weather and the beautifully landscaped grounds, not to mention the delicious luncheon and the talk on current economics by Prof. Jay Forrester.

Pleasant word from Prexy **Norrie Abbot** to indicate that he is still up to his mile-a-day walk and intended to be present at Technology Day. Let us hope, at this writing, a few days before the event, that we have an equally good representation at that gala event. . . . Have a good, relaxing summer to store up energy for the months to come.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

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Augustus B. Kinzel writes, "Hip, Hip, Hooray! No, I'm not going to tell you about my operation, only that a metal device to replace the ball in my left hip has just been successfully installed. Of course, being a metallurgist, I was curious as to its composition. Imagine my surprise to learn that the alloy was Stellite 21, invented by Union Carbide's Stellite research group when I was in general charge of all Carbide's metallurgical research. Even more surprising, the device was manufactured by powder metallurgy using a development which I had suggested when volunteer advisor to the powder metallurgy laboratory at the Stevens Institute of Technology and for which I received the Stevens Institute of Technology Medal for Achievement in Powder Metallurgy. Little did I think then, 22 years ago, that I would personally benefit from these contributions. I get a real thrill out of it. The moral of this story is that when you do good for others you may well be benefiting yourself directly as well as indirectly, and that basic research like a newborn babe, as Ben Franklin said, is worth nothing at the moment but can have a great potential."

There are two deaths to report this month. Belatedly, we have learned that **John A. Scarlett** of Modesto, Calif. died in October 1977, The only news we have about his career comes from alumni registers, which show that he worked for several chemical companies in California including Food Machinery and Chemical Corp. . . . **Aaron Tushin** of Clearwater, Fla., died February 24, 1982. After getting his S.B. degree at M.I.T., Tushin went on to earn a law degree at Southeastern University. He joined the Patent Office in Washington in 1930 and moved to Newton, Mass., in 1952 to become patent attorney for the Ionics Co. Our sympathy is extended to families of these classmates.

A brief note from **Everett Soars** to your secretary asked for the address of **Whitney Wetherell** of Harwich, Mass. Everett and Whitney went to teach in New London, Conn., the year following graduation from M.I.T. The address has now been furnished, and I would like to get further news from both of these men. How about it? . . . Helen and **Bob Miller** of Silver Spring, Md., stopped by on May 21 and had lunch with the Haywards. They both seemed in good health, although Bob had lost quite a bit of weight. They were on the way to Cape Cod to open up their summer cottage and were planning to stop overnight with Emma and **Al Lloyd** in Westerly, R.I. Further plans were to attend Technology Day in Cambridge and then take a short tour around New England. Bob tells me that Marion (Mrs. **George) Chutter** is planning to move from Harwichport, Mass., to Bedford, Mass. Please send me your new address, Marion.

Your secretary attended the annual dinner of the M.I.T. Club of Northern New Jersey on May 19 at which Dr. Edward E. David, Jr., '47, former presidential science advisor and now president of Exxon Research was the speaker. During the business meeting, five former presidents of the M.I.T. Club were elected honorary life members of the board of governors including **Carole A. Clarke** and **Sumner Hayward**. That same evening Cac Clarke phoned and talked to Betty Hayward at length, telling about their annual Caribbean cruise on the S.S. Rotterdam—"fine trip, no accidents this year." The Clarkes are planning to attend Technology Day this year and **Helen St. Laurent** may go with them. . . . A good letter from **Don Morse**, our able 60th Reunion chairman, tells of attending a gathering of M.I.T. senior alumni at the Endicott House in Dedham on May 2. Among the large gathering were Mary and **Ben Fisher**, Marion and **Chesterton Knight**, **Ed MacDonald**, and **Don Morse**. Professor Jay Forrester was the main speaker, talking about the cycles of economic depression. Don reports that he and **Ed-MacDonald** have played some golf together the past two summers although Ed has had some difficulties walking. Now Ed has had his hip x-rayed and has been told he needs a new man-made ball-and-socket joint. Please keep us informed. Your secretary has noted that several of the older classes are now using Endicott House as reunion headquarters with both meals and lodgings there. Don Morse says the house and grounds are beautiful and that M.I.T. is thinking of adding some more rooms. Maybe this would be a good bet for our 65th Reunion.

Ruth and **Irving Jakobson** took a trip to New Orleans in early March and said they had a delightful time walking and touring around the French Quarter. Their tour took them up the river to Natchez and Vicksburg, and they visited some of the fine old mansions. A highlight was listening to Pete Fountain play some of his famous jazz one evening. Jake passed up sailing in the Caribbean this past winter and plans only local sailing round Long Island Sound this summer. . . . Newsy letters from both Emma and **Al Lloyd** came in just in time to meet my deadline. Enclosed was a gem of a poem, applicable to our age, about starting to do a chore and then forgetting what it was. Ah, me! . . . Another enclosure was a clipping from the *Providence Sunday Journal* of May 16, 1982, about **Edson Schock**. Edson was professor of mechanical engineering at the University of Rhode Island for many years, and his avocation has been the designing of small boats. One boat he designed especially for racing at the Point Judith Yacht Club became the biggest racing class at Point Judith: the Point Judith 15s. M.I.T. still has a coaching launch designed by him. The Lloyds made their usual trip last fall to visit son's and daughter's families in McLean, Va., and Atlanta, Ga. Their daughter Barbara and family are now back in Westwood, Mass., after living two years in Switzerland. Emma says she and Al are going to her 55th Reunion at Wheaton this June. Al found during last winter's cold weather that he couldn't take his daily walk outdoors, so he exercised indoors on a stationary bicycle and walked many laps around the first floor. He has continued as church historian taking numerous colored slides of church activities. Another activity has been fixing up old clocks, several of which are now ticking away in fine condition. And Emma keeps active with volunteer work at the local hospital every Thursday morning. Thank you, Lloyds, for your good letters.—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

23 60th Reunion

Tom Rounds reports that after living in Arizona for some eight months, his bronchial asthma has almost disappeared, that he has just passed his 80th birthday, and that he is looking forward to our 60th Reunion.

Rear Admiral **Wesley M. Hague** died on February 10. He was a graduate of the U.S. Naval Academy and received his Master's degree in naval construction and engineering from M.I.T. in 1923. He then was assigned as a lieutenant to the Navy Yard, Puget Sound, Washington. Five years later he was transferred to Balboa, Canal Zone, then in 1934 to the Navy Yard, Mare Island, California. In 1937 he advanced to the rank of commander, and in 1943 to captain, serving as staff commander of the Service Force with the Pacific Fleet. In 1949 he was assigned to the Bureau of Ships, Navy Yard, Washington, D.C., and in 1946 was promoted to rear admiral.

Robert N. Wood died on March 1. He received a bachelor's at Haverford College in 1921 and an S.B. in business and engineering administration at M.I.T. in 1923. Robert was toll traffic engineer for the Bell Telephone Co. of Pennsylvania from 1923 to 1925. He then joined Estabrook Pen Co. of Camden, N.J., serving as assistant to the sales manager from 1925 to 1928, assistant sales manager from 1928 to 1931, sales manager from 1931 to 1958, vice-president and director, 1958 to 1961. He was a member of Rotary, president of the Fountain Pen Manufacturers Association, life member of Sales Marketing Executives of Philadelphia, president of Moorestown United Fund, and president and trustee of Burlington County Memorial Hospital. His hobbies were fishing, photography, and gardening.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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Due to a word processing error in the final stages of the class notes production, the following news for the Class of 1924 was inadvertently left out of the July issue. The editor apologizes to the class and to **Russel Ambach**, *its faithful secretary, who submitted his notes well before the deadline for the issue involved.*

With deep regret, we must report the deaths of three classmates: **Edward J. Hanley**, Dr. **Charles H. Blake**, and Dr. **Hudson Hoagland**.

Edward Hanley, class honorary chairman, died March 13, 1982, in Pittsburgh, Penn. Ed was a giant in the steel industry and in Institute affairs. He gained his S.B. degree in mechanical engineering and later an M.B.A. from the Harvard Business School. In 1951 he received a D.Sc. from Duquesne and in 1956 an L.L.D. from St. Vincent's College. He joined General Electric in 1927, advancing rapidly in operations until 1936, when he became secretary of Allegheny Ludlum Steel. He progressed to president, CEO, and finally board chairman, stepping down in 1972. He chaired the financial committee until 1978, ending four decades of service to the company. As an M.I.T. alumnus and long-time corporation member, Ed served on a number of committees and councils—executive, investment, auditing, material sciences, and metallurgy. He was our 50th Reunion gift chairman and the recipient of many distinguished awards. We are grateful for all that Ed has done for the class and Institute and extend our sympathy to his good wife, Dolly.

Dr. **Charles H. Blake** died December 6, 1981, in Hillsborough, N.C., of a severe heart attack. He was a rare specimen in 1924, who earned his L.I., S.B. and Ph.D. degrees in biology. Charlie was interested in mollusks, entomology, and ornithology and in 1949 had an office at the Institute. At the time he was director of the DeCordoba and Dana museums in Lincoln, Mass., and held various consulting and field service offices. At the Institute he was a three-year member of the Cosmopolitan Club, Chemical Society, and the Fencing Team's épée specialist.

Dr. **Hudson Hoagland** passed away March 5, 1982, in Southborough, Mass. After graduation from Columbia University, he received his S.M. in chemical engineering practice, Ph.D. from Harvard in 1927, and honorary Sc.D. from Colby in 1945. He was a leader in the field of brain wave study and the use of the electro-encephalogram—a diagnostic tool in neurology. For years he was affiliated with the Worcester (Mass.) Foundation for Experimental Biology, which invented the pill. A professor at Clark University (Worcester Mass.) he lectured at schools and colleges here and in England.

Boynton J. Fletcher (Curly?) in Vero Beach, Fla., responded quickly to your scribe's request for the current address of **John Fitch**. A Christmas card was returned marked "Forwarding Address Expired." I thought that he and Mary had gone back to Brazil, but Curly advised otherwise—600 Riomar Drive, Vero Beach, FL 32960. He and Grayce have just moved into 900 Beach

Road, John's Island, Vero Beach, FL 32960.

We have a portion of the envelope to the Alumni Fund from **Rutilio Torres-Saravia** in Mexico—"Activities at my age of 80 years: 1. Plenty of home work (no aid at home)! 2. Walk 3 to 5 miles a day (save money in transportation). 3. Watch the money invested in banks."

The Board of the National Society of Professional Engineers, at its February 17 meeting, designated **Don Luis A. Ferre** of San Juan, Puerto Rico, its first Distinguished Member.

All should have received a March 1982 letter from **Dick Lassiter**, our class agent. It stresses the fact that the cost of an M.I.T. education today far exceeds that of our day and, if the Institute is to attract and develop talent, it must have financial help. The theory is that eventually the assisted talent becomes an asset to the Institute, science, industry and humanity. . . . The Big Three had welcomed **Walt Bagby** as co-chairman of our 60th Reunion when shortly we received word that Frances had fallen and cracked a vertebra. Walt suspects that her recuperation will require his attention, which will detract from his Reunion plans, so he reluctantly withdrew. . . . **Gordon Billard** was located sunning on a Florida beach, so he agreed to execute a limited solicitation for our 60th Reunion gift. He would appreciate everyone establishing a sort of I.R.A., maturing in 1984.

The following news was submitted for the August/September issue of the Review. Paraphrasing the well-known masters of lyrics and music, from Gilbert and Sullivan's *Pirates*—"A scrivener's lot is not a happy one!" We note the passing on of **Charles A. Thomas**, life member emeritus of the M.I.T. Corporation, at his winter home in Georgia on March 29, 1982. He participated in the affairs of the Institute for more than 30 years as a distinguished scientist, leader in the chemical industry, and prominent figure in the development of atomic energy. He prepared at Transylvania College and gained his S.M. in Course V, chemistry. Later, he was honored with doctoral degrees from both Transylvania and Washington University. As a member of General Motors Research Corp., in 1925 he played a significant role in the development of ethyl gasoline. In 1926, he cofounded a research laboratory and in 1945 became the director of the Monsanto Chemical Central Research Department, progressing in two years to executive vice-president, then further to president, and finally to chairman of the board from which he retired some years ago. For his work on the Manhattan Project, he was awarded the Medal of Merit, America's highest civilian award. He served as chairman of a number of national committees including the joint Harvard/M.I.T. program in health services; sponsoring committee for professorship in the development of chemistry and chemical engineering; and a number of visiting committees for biology, city planning, mathematics, and research. We have lost a towering alumnus and staunch friend.

Francis J. Horgan died in Newport, R.I. in 1975 according to a recent query card returned by Patrick H. Horgan II. Francis received an S.B. in electrical engineering. We have no information on his career. . . . A letter to your secretary from Helen (Mrs. **Perry) Maynard** indicates that she was very pleased to receive letters of consolation from several friends and classmates concerning Perry's passing. Helen was kind enough to send new addresses for Gay and John E. Longyear '26: Presbyterian Retirement Home, 17383 Garfield Ave. Apt. 6B, Detroit MI 48240. . . . Dorothy and **Everett Martin** now live at 2100 Morley, Apt. 907, Dearborn MI 48124. . . . **Melvin A. Perkins**, Ph.D. and S.M. in chemistry, sends a note on his Alumni Fund envelope: "Included in *American Men of Science*. Retired from duPont Co. after 41 years of service in organic chemicals department on dyes and organic chemicals."

Mrs. Winifred Nash makes your secretary's duty easier by thoughtfully sending news of the death of **George M. Nash** on April 11, 1982, in Southbury, Ct., ending 54 years of "very rewarding marriage." George gained his S.B. in electrical engineering, was commissioned a 2nd lieutenant in the U.S. Army, worked two years in the U.S. Patent Office in D.C., and then joined the Hudson Gas and Electric Corp., Poughkeepsie, N.Y. After serving in various capacities, he retired in 1968. He was active in a number of civic and industrial organizations, spending ten years in Boy Scouts for which he received an outstanding service award.

At the annual M.I.T. awards convocation, two **Gordon Y. Billard** Awards were presented. They recognize special service of outstanding merit by faculty members. President Gray presented the first to Robert J. Holden, associate dean for student affairs, for his long-time role as facilitator, discussion leader, and mediator of student activities. The second, to Professor Michael S. Feld, professor of physics, for his leadership of the Institute's Equal Opportunity Committee over the past three years, resulting in "a base of understanding and a blueprint for progress . . . to make equal opportunity a reality at M.I.T."

The fearless four—**Don Moore**, **Herb Stewart** and **Russ Ambach** hosted a luncheon by **Ray Lehrer** on May 25—discussed 60th Reunion plans. We still need a co-chairman, and some bills for mailings are not paid. There is some confusion about a class fund managed by the Institute. You should have received a letter and return card from Don Moore, 60th chairman, hoping to uncover an idea of who expects to attend our 60th, as the number is critical in planning.—Co-secretaries: **Russell W. Ambach**, 216 St. Paul St., Brookline, MA 02146 and **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

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Henry Sachs writes bringing us up to date concerning his activities. He believes in trying to stay young and his remedy is to keep busy and moving. As he writes, "I'm still quite active in the insurance brokerage business (though I take plenty of vacations). While in the city, I leave my apartment at 7:45 and walk over two miles to the office and also try to walk home (avoiding New York's miserable transportation system). I take Fridays off during June, July, and August and spend three days at my country club in Westchester County where I can drop out of bed at 7:30 and dig up the golf course from 8:00 to noon. I am most active as an officer of two charitable organizations—an old community center ($4 million annual budget), and a national superagency for home care—as well as ex-officio on a couple of others. Still militarily interested—on the board of my chapter of the American Defense Preparedness Association. Active in my city clubs and my country club in running gourmet dinners, which takes time to strive for excellence. I am actively involved in three French and one German wine and food societies and supervise several functions every year. Our vacations are quite interesting. In September we usually take off for two or three weeks in Italy and France. In 1981 we took a Royal Viking slice of a trip to get away from the cold weather in February—from San Francisco to Aukland, New Zealand, stopping off at Hawaii. Also we take about two weeks off in January for Cuernavaca, Mexico, which has, to our knowledge, the finest winter weather possible. Always stayed healthy at the same hotel but the 'revenge' caught up with us this year, and when I got back home my physician was displeased." Although grounded for a while, Henry is now back to his busy schedule looking forward to the regular vacations and part of a Royal Viking in 1983 from Hong Kong to Durban, South Africa.

Anthony Tsongas writes that he spent the month of February in Mexico, visiting Guadalajara and Mazatlán where he enjoyed the delightful climate, clean beaches, and excellent food. He found hotel and restaurant prices almost double those of two years ago. Many Americans who had retired to Mexico are now selling their homes and returning to the U.S. where the cost of living is lower than in Mexico.

The *Evansville* (Ind.) *Press* reported that more than 600 books and articles about Samuel Johnson, the 18th century literary figure, have been donated to the University of Evansville Clifford Memorial Library by Virginia Clifford, widow of **James L. Clifford** who died in 1978. These books were the working library of Jim, who was well known as a Johnson scholar. The University library is named for Jim's father.

Word of the passing of four classmates has reached me this month, two of which died some years back. **Max Glickman** died in 1974 and **Carroll A. Oliver** on April 19, 1978. Retired Rear Admiral **Theodore C. Lonnquest**, who was an aviator, aeronautical engineer, and staff officer before retiring from active duty in 1956, died of a heart ailment March 9 at Bethesda Naval Hospital. He lived in Chevy Chase. He served in the Navy's flying corps during World War I. Between world wars, he attended the Naval Postgraduate School at Annapolis and served with air units aboard the carriers *Langley* and *Saratoga*. Admiral Lonnquest received the Legion of Merit for his work as engineering director of the Navy's Bureau of Aeronatics. After World War II, he held posts dealing with atomic energy and was on the staff of the joint task force commander at nuclear bomb tests in the Pacific. During the late 1940s he again served with the Bureau of Aeronautics as its deputy chief for research and development. He then represented the bureau at Wright-Patterson Air Force Base in Ohio before retiring. He was a past president of the American Society of Naval Engineers, a fellow of the Institute of Aeronautical Sciences, and a member of the Cosmos Club. He belonged to All Saints Episcopal Church in Chevy Chase. He was a 32nd degree Mason. Survivors include his wife, the former Marie Born, a daughter, and five grandchildren.

Dr. **James M. Lynch** died in Escondido, Calif., on February 20, 1982. He has practiced medicine in Escondido from 1953 until his retirement in 1979. He attended Yale as well as the Institute and was graduated from the Yale Medical School. He studied in Vienna, also. Dr. Lynch taught at Temple University in Philadelphia, at the University of Southern California, and at Huntington Hospital in Pasadena. He came to California in 1937 after spending four years in Panama studying tropical diseases while working for the U.S. and Panamanian governments. This work won him recognition at a convention of the American Medical Association. During World War II, Dr. Lynch served in the Navy Medical Corps and was the first sanitation officer at Camp Pendleton. He also served in the Pacific with the First Marine Division. During the Korean War, he was stationed with the Marine Corps at Parris Island, South Carolina and was later chief of medicine at the Naval Hospital in Corona. He retired from the Naval Reserve in 1961 with the rank of commander.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Courtesy of **Jim Killian** we received, too late to include in the notes for July, the news of Dr. Ulrich W. Suter's appointment as M.I.T.'s first Texaco-Mangelsdorf Career Development Professor in the Department of Chemical Engineering. Dr. Suter, whose degrees, undergraduate and doctoral, were received from the ETH-Zurich, was born in Zurich, Switzerland, and has served on the staff of Stanford University and faculty member of the ETH-Zurich. As a distinguished research scholar, he will be the first to avail himself of the resources left by our classmate **Ted Mangelsdorf**'s son, Frederick, and the Texaco Foundation. You will recall that Ted, a member of the M.I.T. Corporation, was president of the Alumni Association in 1966-67 and was executive vice-president of Texaco, Inc., retiring in 1966, and that his sons, Theodore and Frederick, also attended and received their master's degrees from M.I.T.

Another of our distinguished classmates, **Cyril S. Smith**, is an honorary degree (Doctor of Science) recipient from Lehigh University, having previously received such degrees from Case Western Reserve University and the University of Pennsylvania. He has served as a member of the President's Science Advisory Committee, the

Smithsonian Institute, the advisory committee of the Atomic Energy Commission, and is a Guggenheim Foundation fellow. He has received many awards from professional societies and institutes, and is the author of nine books.

A note from F. Leroy Foster, Class of 1925 secretary, enclosed a clipping concerning **Bill Callahan** with the comment that he had "taught Bill mine surveying back in the dark ages when M.I.T. had a department of mining." The mining engineering publication of AIME announced the grant of the Daniel C. Jackling Award and Lecture to William H. Callahan. He worked with the New Jersey Zinc Co. from 1927 to his retirement in 1970, most of his career being devoted to geological exploration work in the United States and Canada. He was the recipient of the Society of Economic Geology award in 1977, and had served as U.S. delegate to Symposia in Ankara, Turkey in 1964 and Karachi, Pakistan in 1968.

A letter from **Ron Martin**, 501 Pine Hill Rd., Elizabethton, TN 37643, states that he has an extra copy of the 1926 *Technique*. I replied to him that I would publish his kind offer of this memento in the *Review* notes, on the basis of first-come, first-served. . . . We heard from **Pink Salmon** about his tentative plans to visit New England in early June and hope to see him, or, if not, at least at our mini-reunion next year. . . . A delayed letter from Mrs. **George W. Wardner** was routed to me recently, and I thought it advisable to mention the contents because possibly other widows of our class might be interested. After George's death in 1975, Mrs. Wardner received invitations to various social functions, but not for the last few years. We notified the Alumni Office which will reinstate her on the mailing list. In order to accomplish this in any similar case, you only need call Frances Bangs at the Alumni Office, (617) 253-8200 or write to the Alumni Association, M.I.T., Cambridge MA 02139, for that purpose.

A delayed notice of the death of **Neil B. MacLauren** in November 1981 was recently received. There is no further indication of survivors. . . . A notice of the passing of **Frederick C. Balfe, Jr.** on March 12, 1982, was received at the Alumni Office from his widow last month.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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This month we have reports on classmates who have not been recorded previously in our notes. **Roger W. Allen**, Atlanta, Ga., has been an industrial instrument sales engineer and manufacturer's representative. He presently does part-time sales engineering for Dilcher Engineering Co. and is a specialist in Ajax electric salt bath furnaces. He is still active and travels the southern states selling industrial heating equipment. He is a life member of the American Society of Metals. Rog attends the local M.I.T. Club of Atlanta meetings. His hobbies include keeping a 1931 Packard, Leica photography and collecting Leica equipment. He and his wife Ruth, who is an accomplished violinist, like to travel and have been to Europe three times. Rog was in our Glee Club in 1925 and has a good picture of the group in that year. . . . **John B. Drisko**, of Maplewood, N.J., was with the M.I.T. Bureau of Reclamation Soil Conversation and Corps of Engineers working on hydraulic models until 1941, and spent 1942-1954 at Stevens Institute Experimental Towing Tank working on ship models and hydrodynamic research. In 1954 he joined the Tippetts Consulting Engineering firm. After working out a Water Treaty for the World Bank between India and Pakistan in 1960 he started on the design and construction of Tarbela Dam in Pakistan, the world's largest fill dam. Johnny stuck with the dam until it was completed in 1977 and wrote a final report. He retired in 1980. As they say Johnny, a lot of water has spilled over the dam since our ROTC boot training at Fort Humpfreys, Va., when we both used to write to the same girl.

Roger L. Nowland lives in East Blue Hill, Maine, having lived most of his life in Stamford, Conn. He formed his own company, Nowland and Co., Inc., in Greenwich, devoted to consumer research. His research surely was good to select that part of Maine for retirement. (I still sail around those waters every summer) . . . **Capt. Richard C. Turner, Jr.**, who lives in Dalgren, Va., has been with U.S. Naval Ordnance most of his career. In 1957, Dick was executive officer of the U.S. Naval Ammunition Depot, in Crane, Ind. He worked on proximity fuses in Washington, D.C., and missile safety in the Naval Weapons Lab, Dalgren. He retired from U.S. Naval Ordnance in 1964 and Civil Service in 1966. Dick used his Course VI by teaching electrical engineering at the U.S. Naval Academy in 1941 and also was the varsity sailing coach there.

Charles L. MacLaughlin died on March 15, 1982, at Orleans, Mass. In 1936 he started with New Bedford Gas and Electric Light Co. and went through all the phases of gas production. In 1942 he was appointed superintendent of gas operations and at his retirement in 1968, he was in charge of gas distribution. Charley was a member of the Orleans Rotary Club, past president of the New Bedford Rotary Club, and a member of two Masonic Chapters. We express our condolences to his widow Blanche and family. . . . **Daniel C. Metzger** died on March 27, 1982, at Pompano Beach, Fla. His whole career was with Grinnell Corp. in New York City. This is the company known for its sprinkler systems and red piping. Dan was in sales contracting and engineering and retired to Florida in the late sixties. A note from his widow says he enjoyed reading *Technology Review* to hear about old friends. Thank you, Kathryn, and our deepest sympathy from us.

Ruth and I just returned from a delightful cruise on the *Mississippi Queen*, an elegant and spacious paddle-wheeler. We stopped along the river between New Orleans and Vicksburg to visit some fine, large, old plantation homes.—**Joseph C. Burley**, Secretary, 5 Hutchinson St. Milton, MA 02187

28 55th Reunion

A good, cheerful letter from **Henry Gunning** says that he has been wearing his cardinal blazer on several recent occasions. He offered the suggestion that an official Cardinal Club be formed for those alumni eligible to wear the cardinal jacket. He pointed out that Caltech has an annual festive ceremony at which its Half-Century Club welcomes in the new 50-year class. It is interesting to have this spontaneous suggestion from Henry—the general idea has been considered already at several officer meetings of the older classes. One positive result so far (in the Boston area) is a semi-annual luncheon at the Institute's beautiful Endicott House which is attended by 50-year-plus alumni and their spouses. Widows are invited as well. This program was initiated largely through the efforts of Max Seltzer, '18. At the May 2 luncheon our class was represented by **Bill Hall**, Gladys and **Dave Olken**, **Jim Donovan**, and Marjorie (Mrs. **John A.**) **Carvalho**. Speaking of red jackets: perhaps, if you have one, it would be well to see that it is in wearable condition (and still fits!). You will need it in June.

Bill Hurst has written a short autobiography, entitled *Reflections*. This was done largely for the interest and enjoyment of his grandchildren. Perhaps each of us owes something of the kind to succeeding generations. . . . A letter from Mary and **Max Parshall** included a color snapshot of Max with the red 1956 Thunderbird previously owned by his mother, along with the car's present owner, Lionel Baldwin, S.M. '55, dean of engineering at Colorado State University. All appeared to be in good condition (including the car). . . . **George Bernat**, studying some information on the Institute's Development Program, is amazed at the breadth and detail of it all. . . . Judith (Mrs. **Benjamin**) **Miller** sent a card from Israel where she was visiting with her family. . . . **Alexander Tsongas** is researching the genealogy of his family and the role played by General Tsongas in the Greek War of Independence.

With deep regret we must report the deaths of three classmates. **John F. Shaw** died on February 1, 1982. The information was provided by wife Jean. John graduated in Course III, mining engineering, and was a mining engineer for the U.S. Bureau of Mines during his active years. . . . Capt. **Emmett E. Sprung** died November 10, 1981. Report of his death was received from his wife, Mary. Emmett was a graduate student and received his S.M. degree in Course XIII-A, naval construction and engineering. . . . **Lucien Von Schilling** died on December 28, 1981. Lucien was a graduate student in our class and received his S.M. degree in Course XVI, aeronautical engineering. Following graduation he studied for the banking business and became a successful banker. To each family of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Bob Pride and his wife Marion of N. Palm Beach, Fla., spent the Easter holiday with your secretary and his wife, Helen, in their Fort Lauderdale condominium. This has become a tradition of several years, spending Easter in each other's houses, alternately. Later on, my wife and I were guests of the Prides, attending a picnic in Palm Beach, sponsored by the M.I.T. Club of W. Palm Beach. There were about 45 alumni and wives who gathered at the residence of Charles W. Allen '25 of Lake Worth, Fla. Though the weather did not cooperate for outside cooking, we all enjoyed the food (served indoors), the program and scheduled games. Bob and your secretary have been close friends for over 58 years, through high school and M.I.T. . . . I would like to report that over 100 letters have been mailed to the wives of our deceased members, inviting them to join our recently formed widows' program. In the May/June issue of the *Review*, the name of Dorothy (Mrs. **Marshall) David** of Dennis, Mass., was left out in the transcript of the Class Notes relating to the widows' program as one of the initiators. . . . **Arnold S. Wood** of Osprey, Fla., writes, "We are enjoying both our retirement and condominium living, free of grass cutting and other maintenance chores—just flower gardens. We lead a fairly active social life and get to Boston once in a great while. We like visiting North, but not the cold weather. For hobbies, I like to read, listen to soap operas, swim, and walk with my great-granddaughter."

Chung-Foy Yee of Canton, China writes, "It was great to meet you and other classmates at a luncheon at the Faculty Club during my visit to M.I.T. about two years ago. Whenever I think of that occasion, my heart feels with joy and pleasant memories. M.I.T. has changed tremendously. I could hardly recognize some of the places which were familiar to me in my undergraduate days. Since my visit, I have been in constant touch with correspondence with **Bill Baumrucker** and **Warren Walker**. I met them both and their families during my visit. I read the class notes in the *Review* about my visit back to M.I.T. and Bill and his family's visit to China, and I thank you for it as our class secretary. . . . My very best wishes to all my classmates." . . . **Rolf A. Zurwell** of Walhalla, S.C., is still active running Zurwell Co., which specializes in products design and engineering consulting. He states that recently, he had a visit from **Larry Luey** of Birmingham, Ala., and his lovely wife, Natalie. The Lueys attended our last Reunion.

Paul S. Baker of Williamsburg, Va., writes "We enjoyed getting acquainted with many of our classmates during our 45th Reunion, and sorry we were unable to attend the 50th because of Kay's illness; she has made a remarkable recovery." Here are some of the highlights of Paul and Kay's activities in 1981. In March they joined a locally conducted tour of bird-watching and ancient sites viewing in Egypt. This was their first foreign travel since Kay's stroke and they both looked forward to it. Apparently and unfortunately, Kay was not ready for such a strenuous trip, and they cut it short and returned home, where Kay was hospitalized to recuperate from fatigue. By the end of July, Kay was well enough to take a trip to New

England to visit friends and relatives. In November, they took a trip to Florida to spend Thanksgiving with friends; they enjoyed it so well that they went back for Christmas. In regards to activities, Paul says, "a great deal of my time is taken up by maintaining our house and its equipments—the cars, the boat, etc. The way inflation has been, you can't own anything you can't fix yourself. I am still active in environmental problems and belong to York Chapter of Chesapeake Bay Foundation. We do tonging oysters, crabbing, fishing, golfing, assisting in hawk banding during migration, etc. Kay drives, hobnobs with her friends, plays bridge, some golf, and takes her physical therapy. I haven't been too faithful in pursuing aviation interests, but keep in touch with friends associated with aviation including **Jim Redding**." Paul's professional career has evolved around Aeronautics. He was with Chance-Vought Aircraft from 1930 to 1952 covering a wide range of duties: structural engineer, test pilot, chief of aerodynamics and flight test, assistant chief engineer, and manager of the engineering department. Later, he joined Republic Aviation Corp., where he was employed from 1953 to 1964 as development engineer, head of dynamics and flight tests, chief technical engineer and manager of aircraft engineering division. From 1965 to his retirement in 1973, he was associated with the U.S. Army Aviation Mobility Research and Development Laboratory, Fort Eustis, Va., as aerospace engineer. The Bakers have three children and three grandchildren.

If there is anything that **Dexter T. Osgood** of Malverne, N.Y., and his wife Pauline like the most it is travel. His note reads, "Since my last note, we have been on several trips. In February, we took a Panama Canal cruise on the *Love Boat* and a tall ship cruise on the *Sea Cloud*. In March, we took a motor trip to Florida to visit friends and relatives; in April the Coyman Islands; in June, a voyage around the British Isles, visiting England, Wales, Ireland and Scotland, including Orkney Island. In September, we went to Egypt and in November were at our favorite resort, Little Dix Bay, in the British Virgins. We just returned from a cruise to Rio on *Queen Elizabeth II*, with a sidetrip to Iguasso Falls. The tall ship cruise around Martinique and nearby Islands and the British Isles was sponsored by the M.I.T. Quarter Century Club. We have signed up for another cruise with them, as they do a good job. I am enjoying being our class agent, which gives me an opportunity to renew some acquaintances." . . . **John Rich** of Nashua, N.H., has sent a note stating the "the Riches had a vacation on Harbor Island, the Bahamas, in a cottage with M.I.T. friends and classmates, the **Bill Baumruckers** and the **Tom Spellers**. The weather was fine and we had a delightful reunion. Following that, the Spellers and the Riches went on to Marco Polo Island, Fla., for two weeks, while the Baumruckers vacationed with their children and grandchildren at Coral Bay, St. John's Island. It was a great winter to be away." John lists hi-fi equipment, cars and traveling among his hobbies. The Riches have two children and three grandchildren.

In response to my inquiry, **Takanao Kuki** of Tokyo, Japan writes, "I was in the class of 1928 but delayed my graduation on account of illness in my Junior year to 1929. That is the reason why you do not have my records. However, I have several friends in the Class of 1929. My oldest and best known friend and classmate is **John Plugge** who lives in Chevy Chase, Md. He was transferred from George Washington University and also graduated in 1929. I would like to attend the reunions, but the distance makes it difficult. I always attend meetings and parties held by M.I.T. Club of Japan and have met a number of faculty members, including President Gray." . . . I have a note from **Edward C. Roche** of Buffalo, N.Y. as follows, "Thank you for the Birthday card from Class of 1929. Kalidasa's Salutation to Dawn is one of my favorites, which makes you pause, think and take stock of one's doings. . . . Over the Christmas/New Year holidays, we visited our daughter and her family for three weeks in the Washington, D.C. area, which offers many events and programs that we enjoy. We continue to attend and enjoy local ethnic festivals—the Amherst Town Concerts, Amherst Players (program of four days), the Hayes Illustrated Lecture Series, and others. We plan to get to Niagara Falls within the next few weeks while they are iced over and take some pictures of same. Please know that gratefulness is also mine for the light we see, the air we breathe, and the life we enjoy. Would that you, Karnig, your wife Helen, and the rest of '29ers continue to be so blessed."

A note from **Larry Moses** of Sarasota, Fla., reads, "Both Kay and I are well and happy. She has just undergone surgery for a second interocular implant in the right eye this time. The outlook is excellent for near normal vision soon. This is our 50th anniversary year September 2, 1982, and we plan to see all our children with their families in July at Jamestown, R.I., where we met in 1924, spent a week of our honeymoon in 1932, and have visited on a number of occasions. By sheer luck and good fortune, the present owners of Hawthorne Cottage are renting it to us for the month of July. The word has apparantly got around for the plan, and we expect a warm welcome from a number of old friends and visitors. Then in October, a special celebration is apparently being planned here in Sarasota in our honor by our children. Exciting anticipation." Larry lists his hobbies as golf, photography, travel, and volunteer for "surgical assistance" at a local hospital. . . . **Richard E. Bolton** of Westmount, Quebec, Canada has sent a note as follows: "I am now 75 and continue to be in good physical condition. We have just returned from a month's stay on Sanibel Island (Ft. Myers), Fla., where not much happens, and the return to the Canadian reality is a bit of shock. I have finally retired from all work except house chores, gardening, Volunteer Board of Governors, and similar occupations for the aged. I enjoy reading *Technology Review* and I am still unable to solve all the problems except some of the 'speed' ones. As far as I know, there are only about three of my classmates who were friends and are still living: **Gordon Carr** of New York, **George A. C. Holt** of Bennington, Vt., and possibly **Gardiner Lear** of Boston, whom I have not seen in over 35 years. There is not much in this which is of interest to you, but it is my way of saying thank you for your years of wonder work as the secretary of Class of 1929. With best wishes for 1982 to all our classmates."

John Happel of Hastings-on-Hudson, N.Y., has sent me a note reading, "I was saddened to learn the passing of one of our classmates, **Paul Keyser**, who started out at Mobile, as I did, upon graduation from M.I.T. I am spending some time now on a research project sponsored jointly by the U.S. and France program. My youngest daughter Ruth is studying for a Ph.D. at Harvard in anthropology. Best regards to all." . . . I regret to inform you of the passing of two of our classmates. **Miles R. Gray** of Santa Barbara, Calif., on July 15, 1981, and **Paul Keyser** of Shelter Island Heights, N.Y., on February 7, 1982. Paul was one of our most distinguished class members, having devoted years of his talents and time to the service of M.I.T. He has held some of the most important offices and posts, having been a member of the M.I.T. Corporation from 1970 to 1977, member of the Corporation Committee on the Presidency in 1970, and served every aspect of alumni affairs, being elected for two consecutive terms (1970–1972) as president of the Alumni Association. Paul was also active in the Alumni Center of New York, having been its chairman from 1969 to 1970. He worked on behalf of the Sloan School, serving on its Visiting Committee for nearly a decade, from 1969 to 1977, and as its chairman from 1971 to 1977. In recognition of his many contributions to the Institute, the Alumni Association presented him its Bronze Beaver Award in 1972. In 1979, he also received the Marshall B. Dalton Award from the Corporation, being a director and a member of the executive committee. Upon his retirement in 1969, he became a petroleum consultant and held directorship on several oil and energy related companies.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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In going over the material I prepared for last month's issue of the *Review*, I have noted that I failed to mention another "first" for the class of 1930 that occurred about a month ago. Early in March **Ed Kingsley** telephoned to say that Lue and **George Wadsworth** had recently purchased a winter home in Mesa, Ariz., where the Kingsley are now year-round residents and that the Wadsworths would soon be returning to the East Coast. Ed kindly invited Louise and me to stay overnight with him and Betty before the Wadsworths took off for the East. Thus on March 13 we not only had a pleasant dinner at the Kingsleys but also held the first Class of '30 officers meeting to be held in Arizona. . . . It sometimes seems that I see more M.I.T. alumni in Arizona than in Connecticut. Several weeks ago Louise and I decided to attend the Arizona Theater Co. production of *The Gin Game* in nearby Tucson. Having settled myself in an aisle seat I glanced across the aisle and did a double-take; my immediate neighbor on the other side of the aisle was **Ted Riehl**. At intermission time we had a pleasant chat with Margaret and Ted and learned that they were planning a trip east, during the course of which they would probably see the **Jack Bennetts** and the **Bill Jacksons**. . . . After retiring as vice-president and research director of Van Straaten Chemical Co., **George Barker** continued to do consulting work for a time, but he is now fully retired. He and Ida live in McHenry, Ill., where he engages in woodworking activities that include making toys for his grandchildren and various articles of furniture.

Although I have never made an actual survey, I suspect that there are relatively few of our classmates who spend any considerable amount of time on the puzzle section of the *Review*. In this select group of those who do is **Les Steffens**. He is not only a devotee of the puzzle section but is developing a problem for submission which involves the intersection of a plane with an array of 27 cubes in a configuration like that of a Rubik's cube. Les says the problem was suggested to him by his experience in the descriptive geometry course with the problem of an intersecting plane and torus. What a memory! . . . Frances and **Bob Cook** live in Orange, Va., where Bob is still active as an associate of the architectural firm of Bailey and Gardner, specializing in library construction. Since library building has recently been in the "doldrums," the Cooks spent last winter at the Sawgrass Country Club in Ponte Vedra, Fla. where Bob reports there is "great golfing."

Mark Culbreath, who retired in 1969, has been kind enough to send me a very detailed summary of his career in water pollution control and sanitary engineering, primarily with Burnes and McDonnell Engineering Co. of Kansas City. He kept a record of all the business trips he took, a total of 198 trips that took him to nearly every state and a number of foreign countries. His principal current interest is studying the *Wall Street Journal* and deciding what investments to make. He concentrates mostly on the utility stocks where his career experience is advantageous in appraising and evaluating particular stocks. . . . We have at hand a delayed notice that **Mason Hanes** died on October 9, 1981, but unfortunately no details were supplied with the notice. According to my records, as of 1967 he worked for Hughes Aircraft Co. on "radar-oriented" devices in Fullerton, Calif., and lived in Whittier. The Hanes had three daughters and a son.—**Gordon K. Lister**, 294-b Heritage Village, Southbury, CT 06488

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A few inquiries have been received concerning the proposed class mini-reunion, which I haven't answered because I didn't have any information. Our prexy, **Dave Buchanan**, is working on it, and we hope to have something definite to report by early fall. Dave writes, "Saw Evelyn and **Howard Richardson** a few weeks ago at the funeral service of a mutual friend, Cornell '27. They are fine."

Howard sends a note to fill in some of the details about the trip he and Evelyn took to China (mentioned by Dave in the May/June issue of the *Review*). "Last September we flew directly from San Francisco to Hong Kong, nonstop 7,200 miles. Then we flew to Xian, the old capital, an interesting city where life-sized statues of horses and men have been uncovered. We also visited Peking, Shanghai, and Canton. Naturally we were impressed by many things but probably most of all by the tremendous population. Xian, for example, used to be a regional capital with about 50,000 to 100,000 people. It now has one million. We were interested to notice that in different cities the people dress differently. In Shanghai, it was white shirts and dark trousers, in Xian, it was just what they could find; and in Peking, they wore the typical communist garb—blue jackets, etc. They have only been allowing Americans to come in for about four years. The hotels are quite primitive, although they have plans to build better ones."

During our trip to China in April/May 1982, Helen and I flew first to Tokyo, then on to Taiwan, where we spent a few days before going to Hong Kong for a time and then into Red China. In addition to two of the cities Howard and Evelyn visited, Shanghai and Peking (also called Beijing), we visited Hangzhou, Nanjing, Zhenjiang and Wuxi. In addition to the crowds and huge population, we were also impressed by the tremendous number of bicycles and, upon inquiring, we were told that there are no privately owned automobiles in China. Apparently, most people go either by taxi or bus, on a bicycle, or on foot. All of the people we met looked healthy and were most friendly, and the hotels where we stayed ranged from almost brand new and more or less luxurious to livable but not up to our standards. Trying to get a bottle of mineral water without having it taste like sodium bicarbonate was almost impossible, so we drank much more beer than usual. The beer was good.

A note from **Fred Elser** reports that Mardy was operated on April 15 with ball and socket (metal and plastic) replacement in her right leg. When I talked with Fred Sunday, May 22, Mardy seemed to be coming along all right but still had to use a walker. I know all of Fred's classmates wish Mardy well.

The toughest part about writing these class notes is reporting the deaths of classmates. **David F. Walters** passed away on March 3, 1979; **Freeman G. Corkum** died on March 20, 1982; **Louis C. Page, Jr.** passed on November 27, 1981; and **Henri B. Turner** died on November 2, 1981. Our sincere condolences to their families.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

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This is being written ten days before our 50th. The reunion committee has done its work. Our chairman, **Ed Nealand**, has taken Eleanor off to Bermuda for two weeks of relaxation. The telethon workers—**Don Brookfield**, **William Pearce**, **Al O'Neill**, **John Brown** and myself—spent an evening trying to make contact with as many classmates as possible to answer questions about last-minute details.

Following is information about our classmates who would like to come but for various reasons cannot make it. **Charles Taylor** has been retired for 12 years, does consulting work, and is remodeling his home. He has three children and ten grandchildren. . . . **Sterling Stockblower** is working part time now for Englehard. He has a back problem. He reports one child and no grandchildren. . . . **Norman Schulze** is retired from Sprague Electric where he was executive plant engineer. His wife says he is in Europe right now on a consulting project and probably will not be able to get to the 50th. They have three children and six grandchildren. . . . **Stewart Roberts** is still working; he investigates failure of machine turbines. His hobbies are golf and tennis, and the Robertses have two sons, four daughters, 11 grandchildren, and two great-grandchildren. He still hopes to get to the 50th but is not sure. . . . **Lester Glickman** has had a heart attack. Through the loving care of his wife, a strict diet, and eight months of cardiac rehabilitation, he is making a good recovery. He is disappointed that he can't make the 50th, but he's going to try to be at the 55th. He sends greetings to his classmates.

Raymond Schaefer had hoped to attend the 50th, but a business conflict prevents him. He retired at 65 from International Nickel Co. where he was the vice-president in charge of research and development in the U.S. Today he is engaged in Venture Capital. They are active in genetic engineering, especially biogenetics. Sounds most fascinating! Maybe you could send us a story or two about your experiences. . . . **Edwin Beck** has given up hope of making the 50th. He retired in 1975 as chief engineer of Sealed Power Corp. His hobbies are his TR3 Trampcar, stained glass, and traveling. The Becks have two adult children and five grandchildren. . . . **William Steiglitz** is incapacitated, and no recovery is possible. He has 24-hour care in a nursing home. His mind is good and he does the best he can. . . . **Archie Riskin** has a conflicting schedule for the 50th, but he will try to spend an evening with us. . . . **Ira Bach** is a senior project advisor to the mayor of the city of Chicago. Swimming and hiking are his hobbies. He has three children and four grandchildren. He is too busy and too far to make our 50th. . . . **George E. Connor** has a bad case of angina and won't be able to make the 50th. He retired in 1973. . . . We have received the sad news that **Earle M. McKellar** died on August 18, 1967, and that **Gardiner A. Smith** died on October 18, 1978. . . . The next few class notes will be news of those who did attend the 50th. All for now.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Only three contributors this time (one mailing got lost in the mails). **Bill Harper** sends in almost five handwritten pages, almost readable. Bill criticizes me as a loafer, with two addresses, doing nothing at either place. I insist that a translation of Bill's letters is work, and plenty. He retired from Texas Chiropractic College, though the school did not want him to, and when they asked him to return, he would not do that either; maybe he wanted to loaf, too. So, Bill got back to the harness by planting 20 acres of slash pine, in cooperation with the conservation boys. (We planted about as much spruce right on Fort Rock Farm, and built a drainage pond to boot. Enough of us, and shortages will disappear.) To go on with the good work, William built his wife Bobbie a small art studio, furnished it, and it is now in use as predicted. He also bought a small organ and wrote a book on how to play the thing. Just as a change of pace, Bill advises me to remarry, as he did, though I must list this as optional. Seems that he has had more experience with cattle than I have, when he advises me to chase bulls with a golf cart instead of a horse. That's it for Harper, this time around. Many thanks, and best to you both, who always keep the 1933 Alumni Fund in mind.

Mal Mayer wrote Maine that he sent me a card from Antarctica this last winter. Well Mal, I assume that the supply ship never arrived, as I got no card. Mal had little to say about the South Pole but did cover Sarasota County, Fla. He said that, while there, he intended to go hear a speech by my son but could not make it. While on Longboat Key, it is a cinch he did not see the **Prentiss Lobdells** around. They live way north on that key, and nicer folks you ain't met yet. Thanks a whole lot, Mal.

We have a dandy for pacemaker addicts from **Don Fink**. Don had a bad heart attack in 1978, and it was decided that he should use a pacemaker, set at 72 beats per minute, because of irregular heartbeat. (Mine is set for 60 beats per minute, and I have had no heart attacks, strokes, or seizures at all. My pacemaker was also the result of irregular hearbeat, as though there were two sets of beats, and when they got together, I was on the floor. The cardiologist had me spend five days in the hospital, under close observation, and came up with the present operating formula.) Since retiring from IEEE, Don has been with McGraw-Hill Handbooks. As editor-in-chief, he keeps the handbooks up to date and edits the work of over 200 experts. His other retirement job is in the field of the television system of the future—the so-called high-definition TV. This phase is future planning and involves a great deal of travel and meetings with interested TV scientists at home and abroad. His next trip is to Washington to appear before the Federal Communications Commission on public issues raised by the prospect of 1125-line television, already demonstrated by the Japanese to be fully equal to the 35mm projected images in movie houses. We sure appreciate the fine work you have done for your profession, Don. The Institute and your classmates are all proud of you.

I have a little bit to say for some of my own connections with classmates. **Jim Turner** drove me to the Sailfish Club in Palm Beach, to a meeting with 35–40 general alumni invited as sustaining fellows to luncheon with M.I.T.'s president, Paul Gray, and to hear his terse remarks about the Institute today. He mentioned that we now own all the land that we can ever own, as we see it, fronting on Memorial Drive. It was agreed that we sure hit the jackpot when we chose that marvelous man as our president.

Cy Hapgood and I had a fine, congenial luncheon with Nancy Russell, associate director of the Alumni Fund, at the Delray Beach Ocean Club. This meeting concerned the Alumni Fund and the present and future status of the Class of 1933 goal. I was quite surprised to find that Cy lives within a quarter mile of my daughter, Phyllis Carey, on or close to the Intracoastal Waterway. . . . **Don Newhall** reports that he recently came across his "certificate of admission," an item I have never seen. Don stayed at M.I.T. for three years and transferred to Michigan. Apparently he stayed at Michigan long enough to take two degrees, as he spells it plural in his letter. He helps me recall the time when the tuition went up (Was it to $500?) and my budget had no plans for that. I had a friend in Horace Ford's office who made himself a lifelong friend and ignored my lack of legal tender. Don, it seems, had a similar experience. At present, he lives in Walpole, or at least his company is there, a company he started 15 years ago. Don, once a classmate, always a classmate. Please write again, and thanks.—**Warren J. Henderson**, Secretary, P.O. Box H, Exeter, NH 03833

35

I started to write this a week ago but waited until the entries started coming in for the 22nd Annual Class Golf Tournament, because I just did not have any good news to pass along. It is quite apparent that the older we become the more we become susceptible to all kinds of maladies and misfortunes that can bring unhappiness to us and our loved ones. I know there is a strong balancing factor full of new, exciting, and interesting experiences happening all the time, and I've been waiting for that kind of news so I could tell you all the information I have. Taking it from the top: **Leo Beckwith** reports that Betty is showing good progress in her recovery since they got home to Swampscott last week. (This is being written May 29.) . . . . **Ned Collins** had a stroke in early April and is recovering at home after a relatively short hospital stay. The extent of his progress can be measured by the fact that he sent in his usual golf entry and said he expects to be playing by mid-August. . . . **Hal Bemis** sent his entry with this note: "I shall be away all of the time, so this may eliminate me before I begin." . . . **Sid Grazi** reports that he and Anne were heading back to Denver after spending the winter in LaCosta, Calif. . . . **Sam Brown** wrote that he would be away from June 7–9 in California (I can guess its a Kai-

ser board meeting), in Florida June 12-20, and in Minnesota and Wisconsin July 18-25; the rest of the time home in Short Hills, N.J. . . . **William T. "Bill" Barker** wrote that he would not be able to rejoin the golf this year. He has a separate office phone number, so I suspect the real estate business is going okay.

A nice long letter came from **James Libby** in Hockessin, Del. "Many thanks for the letter and the invitation to participate in the golf tournament. I haven't played golf since I retired, so do not think that I'd do much more than contribute towards the winnings of those that have kept at it. Now if you would program dinghy racing on the Charles, I might be with you. At the moment, *Zenende* is not quite ready for the water, but these Dutch steel hulls take a lot of spring maintenance. You may recall that I owned her with **Thonet Dauphine** for a while. Have you caught up with the fact that **James Parker** was seriously ill with prostate cancer last fall? He has made a remarkable recovery and we are going to Baker's Island with them in July as usual. We visited them in April, and you'd never know he had been sick. On another theme, we are interested to note that a pink Cadillac we spotted not too long ago had a vanity plate MARY K. I couldn't tell what state it was. If we hadn't gone to the 45th Reunion, we would have wondered what it was all about. (Doreen is still going strong in it.) Your move to Connecticut might appear to indicate another career change. I wish you every success and will be looking for details in the class notes. If you have access to an address list for members of our class I would appreciate knowing the current one for **Rollin D. Morse**. He retired from duPont shortly before I did but seems to have moved away from the Newark-Lincoln University area. Another friend of mine, **Roy P. Whitney**, has also retired but I have trouble getting him to write, although we always hear from them at Christmas. Talk of the 50th begins to sound very good—keep at it."

Dick Shaw wrote that they will be away in July, but otherwise only occasional weekends will interrupt the order of their retirement at least for the summer. . . . I also received a long letter from **Les Brooks** from which I shall quote one paragraph and leave the balance for next issue, as it would take me well over my allotted space. Les says, "Last Christmas one of our children gave us a week's Caribbean cruise to celebrate our 40th in February. We left Miami on February 6 on the *Song of Norway*, and we loved it. You can't beat the Norwegians for service, meals, cleanliness, etc. etc." . . . As for your secretary, unfortunately there is more to my move than just a career change and I shall try to tell you more about it next time. In the meantime, I hope you have a good summer, and please do write and tell me what you are doing, going to do, or have done—and that goes for your children and grandchildren and by all means great-grandchildren!—**Allan Q. Mowatt**, P.O. Box 92, Newton, MA 02195

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In the last issue I reported the death of **Roger LeBlanc** last December. Now an obituary notice has come my way, and I can tell you more. He was retired as vice-president of J. J. Moreau and Sons and had been active in the Manchester, N.H., business community for many years as well as in many volunteer activities. He is survived by his widow, Marjorie Moreau LeBlanc, two sons, a daughter, and five grandchildren. . . . From the Alumni Office I have received word of the death last October of **C. Donald Brown**, captain USN retired, in Winchester, Vir. Following his retirement from the Navy he was assistant director for continuing engineering education at George Washington University. He was another of the "graduate" members of the class. . . . **Gerry McMahon** writes that he and Catherine on their way through Orange, Tex., called **Vernon Osgood** and found that his wife had died shortly before. She suffered a heart attack while the Osgoods were at an orchid show in Albuquerque, N.M., where he was serving as a judge. The Osgoods have two sons and five grandchildren. Vernon is retired from duPont and they have lived in Orange some 35 years. I am appreciative that Gerry and Catherine have kept in touch with the Osgoods. They report also that they have acquired two new grandchildren, bringing the total to nine. . . . **Henry Runkel** has written to say that he and Natalie have finally become grandparents with the birth of Bryce Matthew Runkel simultaneously with his father's completion of his Ph.D. at Purdue. In late April the Runkels celebrated their 42nd wedding anniversary with breakfast at Snoqualmie Falls Lodge, a country inn outside of Seattle. They were joined in the celebration by Vivienne and **Eli Grossman**. Henry enclosed a nice photo of the four of them with a garden backdrop. He also sent a brochure on the lodge, which makes a specialty of "old fashioned country style farm breakfasts." It sounds like fun!

Eli sent me a clipping from the *Hartford Courant* featuring Ruth Cohen, the widow of **Art Cohen**. When Art suffered a fatal heart attack while they were vacationing in Arizona, he had the preceding year started a company to manufacture a device called the "airpot," a precision shock absorber for high technology applications. Ruth has carried on the business and in the process has learned much about the problems of small businesses. She has been honored by being named a U.S. Businessperson of the Year by the Small Business Administration. She has been very active in efforts to try to improve the climate for small business across the country as well as in her home state of Connecticut. . . . As often happens, these notes are due just before Technology Day, so any new information I glean there will have to wait for the fall. Meanwhile, if any of you are planning a fall vacation in these parts, be advised that I will be "at home" on Saturday, October 30.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT

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I recently had a long telephone conversation with Admiral **Peter V. Colmar**, who is now retired and living in Seattle, Wash. After retiring from the Coast Guard, Peter worked with the Laurence Radiation Lab of the University of California and then with Boeing Aircraft. Included among his activities is a great deal of sailing. . . . The Institute of Electrical and Electronic Engineers, Inc., Press has announced the publication of *Electronic Switching: Digital Central Office Systems of the World*, edited by **Amos E. Joel, Jr.**, of Bell Laboratories. This book contains 29 papers on 26 digital time-division switching systems selected to illustrate the tremendous change which has taken place during the past few years. . . . **Milton Green** writes that he took early retirement from Polaroid in May, after 31 years of service, but continues his association with the corporation as a consultant in the interface between chemistry and toxicology.

John Kirk sends a note with his annual class dues regarding his family's recent activities. John and Elizabeth enjoyed a retirement trip to Cancun, Mexico, this past winter, returning home to New Jersey in time to dig out of the 14-inch blizzard which arrived in early April. Tom, his youngest, hopes to get his Ph.D. in chemistry from Princeton in September. Susan, his eldest, is thinking of giving up her professorship at the College of St. Elizabeth in Convent Station, N.J., and becoming a full-time mother to her two children. . . . A news clipping indicates that **Ralph N. Thompson** has been named senior staff vice-president of Thiokol Corp., Newtown, Pa. Thiokol is a manufacturer of specialty chemicals and solid-propellant rocket motors. . . . If you are interested in sharing your vacation experiences with us, please send us a note.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030

43 40th Reunion

There is a very thin crop of news this month. I almost had to use a note from the Class of '42 that was sent to me by mistake. Fortunately, **Charles A. Duboc** was mentioned in the *New York Times*. Charles, who is currently chairman of the board and "chief executive financial officer" (sic) of Western Casualty and Surety Co., Ft. Scott, Kans., has been elected to the additional post of chairman of the executive committee. I hope to hear someday the story of how a Ph.D. physicist worked his way into those positions.

The Benham Holway Power Group, Tulsa, Okla., headed by **Bill Holway,** has received a national award for its Lawrence Hydroelectric Project, located on the Merrimack River in Lawrence, Mass. Lawrence Hydro is one of the first of the modern lowhead bulb-generator hydroelectric projects constructed in conjunction with an existing dam in the United States, and was selected as one of the ten Outstanding Engineering Achievement Award winners of the National Society of Professional Engineers for 1981. The Benham Holway Power Group is a successor to the engineering firm founded by Bill's father, the late W. R. Holway, '15.

Please send in your news, or else it's back to the telephone.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Stanley C. Smock, Jr. writes: "All three of our daughters, and their men, are now involved in our ranching operation, as Jean and I prepare for retirement. In addition to cattle, we are now breeding German Holsteiner horses for dressage, jumping, and hunting. Not the normal M.I.T. grad activities!" . . . **Norman L. Greeman**, president and CEO, Rogers Corp., Rogers, Conn., addressed the annual Danielson (Conn.) Exchange Club Industrial Night on "Industrial Growth Through Technology." Norm's entire business career of 33 years has been with the company, holding various technical, development, marketing, and executive management positions. He has guided the transformation of Rogers Corp. from a local company primarily producing electrical insulation to a worldwide $100-million corporation that manufactures a wide range of engineered electronic components and materials. . . . **C. William Ritterhoff**, executive vice-president, Bethlehem Steel Corp., is one of the three management directors of the company who did not seek reelection when his term expired. The board at Bethlehem decided to increase its proportion of outside directors. . . . An obituary of **Franklin R. Farmer**, who was a civil engineer with the U.S. Department of Agriculture, Soil Conversation Service, at Orono, Maine, notes his death on April 2 at Bangor. We extend our sympathies to his widow Laura, his children (Christina, Michael, Laurel, and Mathew), two brothers, and three grandsons.

A long letter from **Robert I. Clarke** details his recent problem. Bob wisely decided to stop off at the hospital on his way home from work last March when he felt unusual pressure on his chest. After days of observation, tests, several consultations, and second opinions, Bob underwent coronary bypass surgery in April. By the time you read this, he hopes to be back at work. He added that his son Bruce, who has his Ph.D. in plant pathology, was appointed an assistant professor at Rutgers; his son Bob is working on his Ph.D. at the University of Maryland; his daughter Linda became engaged and plans to finish her last year of college before getting married; and his wife Mary is adjusting well to all the changes in their lives.

On May 8 Anita and **Les Brindis** hosted a dinner at their home for your 40th Reunion Committee. Attending were **Andy Corry** and guest, Jane and **Louis Demarkles**, Janice Kispert, Ruth and **Norman Sebell** and guests from Lexington, **Melissa Teixeira**, Edna and **Stan Warshaw**, and Doris and **Chet Woodworth**. The Warshaws reported that Wentworth-by-the-Sea was not available following Technology Day. However, more recent news raises our hopes that the inn's new wing will be completed and available to us at that time. More details will follow the committee's meeting planned for late August.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

45

Although written for the July 1982 issue of the Review, *the following 1945 news was held over because of space limitations.*

In January 1982 **George Berman**, chairman and president of Unitrode Corp., was elected to the board of directors of United Way of Massachusetts Bay. . . . The December 8, 1980 *Forbes* had an article on **Hal Thorkilsen** captioned, "The Little Man's Monopoly." Hal is president of Ocean Spray Cranberries, a farmer's cooperative that has 85 percent of the principal market and often racks up net margins of more than 25 percent! How about those numbers, guys and gals? If you eat turkey or drink grapefruit juice, you must know about Ocean Spray, particularly the new packaging scheme they are now bringing to market. My sailing friends report that Hal continues to earn his share of silver racing his Tartan 40. . . . At last report, **Bill Loeb** had forsaken the Greater New York battle to settle in western Massechusetts as president of West Stockbridge Enterprise, Inc. By reading between the lines of an 18-month old news clip, I would conclude that Bill and his firm were primarily consulting engineers in the solar, hydro, wood energy field.

Ed Stoltz, Jr., now a registered professional engineer in Englewood, Colo., retired from Johns Manville in November 1980. Ed's partner is a former vice-presidnet/purchasing from 3M, and it would appear this twosome was having great fun headhunting for lawyers and engineers, arranging small acquisitions and brokering materials such as fuel oil, sawdust, etc. Ed continues active as director of the Colorado M.I.T. Club—and, oh yes, we did enjoy seeing Ed and Elinor at the Institute last June. . . . **Bill Humphreys** who, the last we knew, was a hotshot peddler type with Autocall in Shelby, Ohio, now reports that he is successfully growing soybeans, corn, and wheat in the Midwest farm lands.

Hopefully, most of you caught the clip on last years's Corporate Leadership Awards of the Institute wherein **Hal Rover** was recognized as vice-chairman, SSC&B Advertising in New York City. . . . Late last summer, **Don J. Lovell** published *Optical Anecdotes*, some 36 delightful stories about man's quest to understand the nature of light for the past 5,482 years! Don indicated that he collected the material for some 20 years and further stated, "You have no idea how pleased I am to have finally made it to publication!" . . . We just recently learned that **James E. Hoff** passed away on October 15, 1981.

We continue to receive and enjoy, despite the occasional odd hour, phone calls from **Julian Busby** and **Vince Butler**. Buzz still lives in Okmulgee, Okla. wherein he continues his wildcat activities in both the oil and gas arena; Vince, on the other hand, enjoys (not necessarily this past winter!) Vera Cruz, Calif. Son Buzzo, named for the individual above, is a Pac 8 basketball star. To hear papa tell the stories of son's activities, one must conclude that Vince was a frustrated bench warming basketballer at M.I.T. I hasten to add that it is a good thing Vince made the swim team—or else! —**Clinton H. Springer,** Secretary, Box 288, New Castle, NH 03854

46

Oops! Apologies submitted by your rookie class scribe. When I wrote the copy for the May/June class notes, I neglected to enter my by-line at the end. So, the *Review* staff defaulted to **Russ Dostal**, to whom I also apologize. Larry, Stan, Ernie, and the rest are probably all wondering how Russ got all that info.

Moving rignt along, but not very far, we have a bare trickle of inputs for this edition. I may have to fake something. In fact, I'll just browse through the roster here and ask *What-ever-happened-to:* **Bill Cahill**, whom I see listed as living in Incline Village, Nev., on the shores of beautiful Lake Tahoe? . . . And how 'bout **Warren Chapman** with whom I climbed in the Sangre De Gristos in the summer of '49, just before he got his M.D.—now listed as professor of urology at the University of Washington, Seattle? . . . And **Jim Corbett**, last "seen" as director of advanced systems at Grumman out on Long Island? . . . And good ol' **Bob Dixon**, an ex-roomie, still a meteorologist with the National Weather Service, and living in Fairfax, Va.? . . . and Bob's "other" roomie (there were dozens as I recall), **Bob Fagot** in the Psychology Department at the University of Oregon in Eugene? . . . And **Beverly Bean Graham** (with a Course XVI Ph.D.—wow) working in her husband's company on Shaw Island, Wash.? . . . And nearby **Carl Jensen**, a semi-ex-roomie, now an attorney in Seattle? . . . And finally (you guessed it) another ex-roomie, **Al Little**, doing astro-electronics with RCA in Princeton.

That takes us down to the *Ls*. Next issue we'll hit the other end of the alphabet. If there's anyone I've mentioned who'd care to write—as correction, or just for auld lang syne—feel free!

Some quickies as deadline hovers: **Fred Ross** was just named president of newly formed Raymark Corp. in Trumbell, Conn. . . . **Alan Gruber** is chairman and chief executive officer of Orion Capital, an insurance holding company in New York. . . . Likewise, **Charles Peck** was named chairman and chief executive officer of Ryland Corp., a home building concern in Columbia, Md. . . . Finally, **George Bott** recently moved to Grumman Data Systems (presumably on Long Island, New York). . . . Take care; keep in touch—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

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It may be August where you are, but where I sit, it's April, and our 35th is yet to be. Hope you all had a grand time. It will have been (new tense?) so good to see so many of you there!

Aaron Newman writes of a business trip last October to Manila to see the Philippines' first nuclear power plant. "Extended trip into a very pleasant vacation to Hong Kong, Kyoto, Tokyo, and finally a stopoff in San Francisco to visit with my daughter Iris, who has been working there for Hertz Corp. for the past year." . . . **Paul Cook**, president and CEO of the Raychem Corp., is a trustee of the Center for Biotechnology Research, an industry-funded non-profit facility for research at Stanford and the University of California, Berkeley. . . . **William Becker**, president and CEO of Bacon Felt, Taunton, a highly specialized, non-woven textile manufacturing company, is the new president of the Morton Hospital board of trustees. Bill has been with Bacon Felt since 1953, following work in New Hampshire as part owner of the Manchester Yarn Mills in Manchester, N.H., and service in the Navy in Korea. He currently has overall responsibility for the profitable operation of three facilities, two in Massachusetts and one in Chicago. He is credited with managing the transition and reorganization of the company to new ownership and negotiating the successful acquisition and incorporation of two new product lines and the establishment of two new manufacturing plants. He has served as director of Cooper and Co., Bryn Mawr, South Wales, and is chairman of the Industrial Trade Association, Felt Council NTA. He has authored numerous technical articles and patents. Bill lives in Raynham with wife Rosamond, son Jonathan, a student at Raynham Junior High, and daughter Nancy, a respiratory specialist at Morton Hospital. Daughter Diane is executive director of the Red Cross in Rome, N.Y.; daughter Suzanne works at the Concord, N.H., Clinic.

Pratt and Whitney Aircraft has named **John Connors** to the new position of vice-president of the PW202X engine program for the Commercial Products Division. He will be in charge of determining market requirements for such an engine in the 20,000- to 30,000-pound thrust class and will represent Pratt and Whitney in negotiations with potential users and partners. John joined Pratt and Whitney in 1948 as an analytical engineer and has held positions in engineering, marketing, and program management. . . . **Walter Rotman**, a staff member at M.I.T. Lincoln Laboratory, where his responsibilities include the development of EHF satellite communications antennas, recently made a presentation describing three dielectric lens designs under development at Lincoln Laboratory for potential military satellite communication (MILSATCOM). Until 1980, Walter was with the Air Force Cambridge Research Laboratories and RADC, where he conducted and managed research on antennas and microwave components for Air Force applications. . . . **Robert Balluffi**, professor of metallurgy at M.I.T., has been elected to membership in the National Academy of Sciences, in recognition of his distinguished and continuing achievements in original research. This honor is considered to be one of the highest that can be accorded an American scientist or engineer.

It is my sad duty to report several deaths. **Mort Lowenthal**, who received his doctorate with our class, died May 18 as the result of a heart attack suffered on his way to class at Northeastern University, where he had been a professor for 16 years. **Jack Rizika**, who was in Israel when he learned of Mort's death, bought a grove of 150 trees in his memory, as a memorial from the class. The certificates will be sent to Mort's mother. Anyone who would like to participate in this memorial may contact any class officer. Mort was admired as a dedicated teacher, accomplished pianist, gourmet chef, horticulturist, an authority on communications via meteors, and for his activity in the Massachusetts Democratic Party. Mort was faculty adviser at Northeastern to the electrical engineering honorary society, Eta Kappa. He left teaching at M.I.T. in 1949 to join the Sylvania Electronics Division, where he was head of the Theoretical Group, involved in the development of advances in electronic devices for air traffic and marine radar use. From 1952 to 1965, he was a research scientist at M.I.T. Lincoln Lab where he investigated so-called radio propagation phenomena. After a year at M.I.T. as associate professor, he went to Northeastern. He was active in many technical, horticultural, and musical organizations. He leaves his mother, Leanne Lowenthal of New York City. . . . **David Campbell** died in January. David worked as a hydraulic engineer in Boston from graduation until his retirement in 1977. At the age of 15, he began full-time study at Harvard. After World War II, he joined our class at M.I.T. He was a member of the American Society of Civil Engineers and served at one time on the board of the Freeman Fund of M.I.T. He leaves his wife Mary, son James, and daughter Linda. . . . **Don Aiken**, who died in May 1979, was the manager of research and development in the B.F. Goodrich Chemical Division, Independence, Ohio, at the time of his death. . . . **Walter Kisluk** died of cancer in April. He was president of Altek Inc., Aurora. From their local paper: "Kisluk is survived by his wife Jill, who nursed him through his illness both in the hospital and at their home; by his younger son Peter, who provided the family with prayer and music; and by his younger daughter Gwen, who married her fiancé, Mark Skeva of La Grange, in her living room to provide her father with the joy of giving her away, instead of waiting until June when the couple had planned to marry." Walter is also survived by daughter Jan, "who has made several trips back and forth [from New Hampshire] to be with her family"; and by son Michael, "whose quiet and constant emotional strength has supported the entire family in its sorrow." Our sympathy goes to all of the families of our classmates who have left us.—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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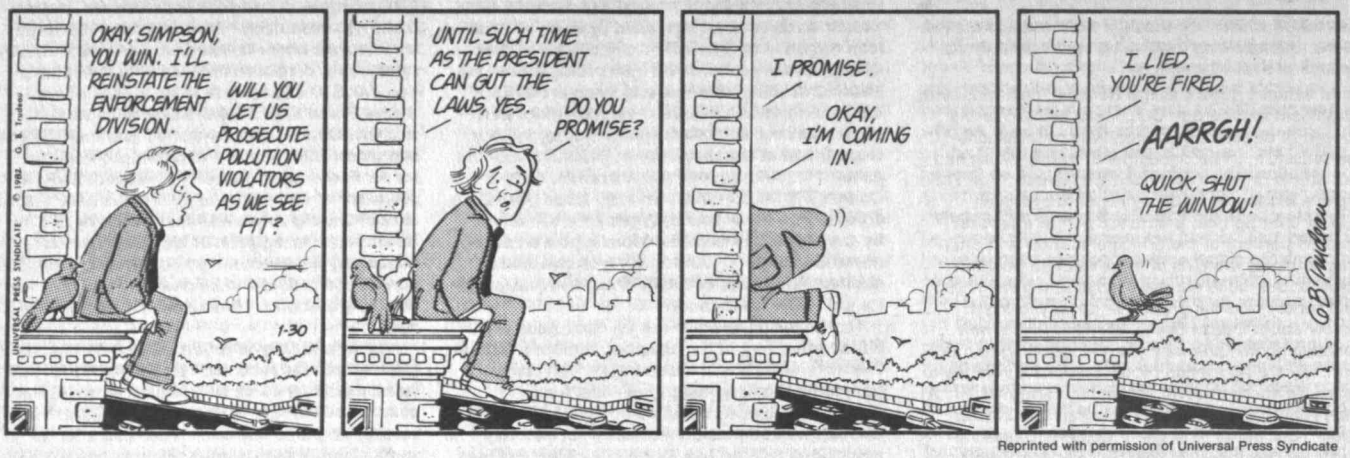
Denny McNear, president of the Southern Pacific Transportation Co. in San Francisco, will be president of the Alumni Association for 1982-83. He leads a slate of 11 officers and Corporation nominees chosen by the association's National Selection Committee early this year. Among others chosen by the committee for positions on the Alumni

DOONESBURY **by Garry Trudeau**



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An article in the Washington Post *early this year describes events surrounding a tongue-in-cheek memo circulating in the Environmental Protection Agency (EPA) allegedly authored by* ***John Horton, '49,*** *a Reagan administration appointee. The memo was stimulated by a "Doonesbury" cartoon (above), which depicts Ted Simmons, an EPA bureaucrat, showing his distress over budget cuts by perching on the window ledge outside his office.*

Because of Simmons, according to the memo, the EPA has been forced to impose new security practices on window and window ledge use. Ledge-sitters, the memo maintains, must be given the choice of jumping or being pushed. The memo makes an egalitarian attempt to accommodate "those individuals with creeds which require access to ledges," suggesting they might try the Crystal City facilities which "are significantly higher, and their use will result in a greater likelihood for success for administration holdovers who are seeking new opportunities."

Horton's secretary was quick to explain that it was not an official memo, and (according to the Post *story) Horton took the faked memo with "utmost magnanimity."*

Association's Board of Directors for a two-year term is **Louis Kreek**. . . . **Verity Smith** was named the 1982 recipient of the Max Hecht Award by ASTM. Verity was recognized for his outstanding contributions to the advancement of voluntary standardization. The Max Hecht Award was established in 1954 and is presented annually to a member of at least three years who has performed some distinguished work in the committee in the field of water.

Verity began his career as a research associate in the Department of Chemical Engineering at M.I.T. working on the application of fluidized powder beds to the recovery of pure metal from ores. Later at Dennison Manufacturing, he was involved in applications of polymer chemistry to paper coatings. Next, at Barnstead Still and Sterilizer he combined the position of sales engineer with the duties of lab technician. His efforts were directed toward the development of ion exchange processes, improved water distillation equipment, reverse osmosis, and ultrafiltration. Verity has been issued over 20 process and equipment patents. He formed Vaponics, Inc. and is president of his company. Vaponics is a leading manufacturer of equipment to provide high purity water for several industries including semiconductor manufacturers.

Charles Dolan's father died in Honolulu several months ago. Mr. Dolan was the last surviving member of the Lafayette Escadrille, the Americans who volunteered to fly as an American unit within the French army before the U.S. entered World War I. The Lafayette Escadrille was known for its glamour and its gallantry as well as its outstanding military record. The small unit was officially credited with downing 199 enemy planes. Only six of the 38 American members of the unit survived the war. Mr. Dolan had two confirmed victories and eight other probable victories. On behalf of our class, I extend our sympathy to Charles on the death of his father. . . . **Irwin Lebow** completed six years with the Defense Communications Agency as Chief Scientist. He recently joined American Satellite Company as vice-president, engineering. His older son, William, received his master's degree from the Institute in statistics. His younger son, David, is a member of the class of 1983.

The M.I.T. Sustaining Fellows program has the objective to attract and recognize individuals who would like to assist M.I.T. in carrying out its mission, through financial support, and to provide sustaining fellows an opportunity to learn about M.I.T. research and teaching programs. **Denny McNear, Vincent Vappi, Bill Weisz** and **Bill Zimmerman** are members of the sponsoring committee. In addition to these classmates, **Bernie Gordon, Ed Hiam, Phil Macht,** and **Peter Saint Germain** are life members. Annual members are **Nick Caldwell, Abraham Dranetz, George Keller, Warren King** and **John Weil**. This is not a complete list, but it does show the support these classmates are providing to M.I.T. . . . **Bob Welsh** has been named vice-president of Parker, Eldridge, Scholl, and Gordon, Inc. in Waltham. The firm provides consulting services to business. . . . **Bill Reinhardt** writes that his wife, Parks, died painlessly after a four-month bout with cancer. Bill kept her at home till the end, and highly recommends that to all. Our sympathy to Bill and his family at this time.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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We have received some news from our wandering classmate, **Russell Cox**. He and Susanna attended the 34th M.I.T. Mexican Fiesta and had a wonderful time in the Yucatan. They also had a mini-Mexican reunion with Eleanor and **Bill Howlett** from Washington, D.C., with Shirley and **Chuck Holtzwarth** from Illinois, and Belve and **Charles Walker** from Houston. . . . **Walter Seibert** is now on his own as a consultant to the minerals industry. The last of his six children is in his fourth year at Rutgers. Three grandchildren also, so far! . . . **William C. Schneider** has retired from NASA and is now vice-president of product development for Computer Sciences Corp. He has fully recovered from an aortic valve replacement. . . . **George Hatsopoulos** has been elected a director of the Federal Reserve Bank of Boston. George is president and chairman of Thermo Electron Corp. . . . I am writing this a couple of weeks before Technology Day and am disappointed that my plans to attend had to be called off. But we only have two more years until our 35th Reunion. Where do we want to go? What do we want to do? This transplanted Easterner votes for that magical isle of Bermuda again—anytime! Does anyone else agree? Write me, your secretary, with your choice.—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017

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George H. Dickson recently joined Trans Energy Systems, Inc., as manager of electrical engineering. The firm specializes in co-generation, boiler plants, and industrial facility consulting engineering. . . . For the last five years, **Lee C. Richardson** has worked for EG&G in Idaho, where he manages the hot cells. He spent 14 years at Foote Mineral (ending up as director of research) and seven years at Westinghouse. . . . Since **Juan M. Navia** left M.I.T. (the second time around after obtaining a Ph.D. in 1965), he has been at the Medical Center of the University of Alabama in Birmingham, teaching and doing research in the area of nutrition and its effects on oral tissues. Juan has kept up the tradition of M.I.T., working (and stimulating others to work) like "eager beavers." Presently he is professor of nutrition and public health and director of the Sparkman Center, which is dedicated to the establishment of academic programs in universities in developing countries. Juan finds his work exciting and fulfilling. He and his wife are enjoying their stay in the South with their two sons and two daughters. Last June Juan had the great satisfaction of seeing his son graduate with a Ph.D. in organic chemistry. He sends his best to the class and especially to his Course XX classmates, whom he remembers frequently.—**John T. McKenna, Jr.**, Secretary, 1 Emerson Place, Boston, MA 02114

53 30th Reunion

Spring (as this is being written) has been busy and many items have accumulated, so I'll get with it. **John Walsh** returned in 1978 from 18 years abroad (London, Paris, Geneva, and Brussels). He is now president of York International, Borg Warner. Recently he was listed in *Who's Who in America*. He's still married to Christine, and they have four children. . . . **Alfred Switendick** is on temporary assignment from Sandia Laboratories in Albuquerque to the U.S. Department of Economy Office of Basic Energy Research. . . . **Robert Bonazoli** (electrical engineering) has been with Sylvania Lighting Group for 25 years. He is now chief engineer for the Industrial Commercial Division. . . . **Clifford McLain** has been appointed vice-president for corporate development at Systems Planning Corp., Arlington, Va., working on Department of Defense studies. The company is doing its best to hire as many new M.I.T. grads as possible.

We have heard that **Thierry Thys** is president of Investment Casting Institute. . . . **John Rempert** is celebrating his first grandchild and a new job as senior civil engineer with C.F. Braun and Co. of Alhambra, Calif. . . . **Allan Hoffman** remains professor of chemical engineering and bioengineering and assistant director of the Center for Bioengineering at the University of Washington in Seattle. He was the 1980 Tederly Science Lecturer plus the main lecturer at the IUPAC Macromolecular Symposium, Strasbourg, France, in 1981. He also served as special plenary lecturer, International Atomic Energy Commission, in Grenoble, France.

Chuck Homsey has been spending a large percentage of his time at his surgical implant company, Vitek, Inc. The company's research on improved hip implants at the Texas Medical Center has led Vitek into European marketing and a major expansion for the company. . . . **Jerome Tieman** went to GE Corp., research and development, after earning his Ph.D. at Stanford. He is still there, although his field has changed from physics to electrical engineering.

David Cravens, author, speaker, and consultant, is a frequent participant in management seminars and conferences for business executives. He has been on the faculty at the University of Tennessee, Knoxville, for 14 years. . . . **Charles Forman**, executive director of the American Institute of Chemical Engineering, has been reelected to the post of secretary of the AIChE, the 53,000-member national technical society. He has had a 20-year career with Abbot Laboratories, North Chicago, Ill. Dr. Forman is listed in *Who's Who in America, American Men and Women of Science*, and *Who's Who in Engineering*.

Fred Brecker wrote a long letter indicating he, Sandy, and their four children are all healthy, active, and growing older. That last one I threw in because he mentioned that the reunion is on the horizon, and he has been thus far unsuccessful in lining up a reunion chairman. Any of you living in the vicinity of Boston who would like to serve on the committee, just drop me a note.—**Gil Gardner**, Secretary, 3400 Rusticway Lane, Falls Church, VA 22044

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We received word from **Perry Smoot** that his son Peter is in his freshman year at Tech and "thinks M.I.T. is great!" It's also expensive, so Perry's wife Ursula is working in a bank to help with the costs. Perry is working on the development of metal matrix composite materials of high stiffness, high strength, and low density for use in bridges. . . . Major General **Charles Palmer** received the Army's highest meritorious service award after four years as commander of the 124th Army Reserve at Fort Lawton, Wash. Charles was a distinguished military graduate of our ROTC program. . . . **Paul Gross**, who also garnered degrees from the Morton School of Business at the University of Pennsylvania and from Columbia University, chaired a program sponsored by the Westerly, R.I., branch of the American Association of University Women.

Alfredo Peralta-Maninat has been with the Venezuelan state-owned steel mill, C.V.G. Siderugica Del Orinoco, C.A. (SIDOR), for 21 years. He is a board member of SIDOR and was responsible for the planning and contracting of the expansion of SIDOR from one to five million tons of steel per year. He is now also president of C.V.G. Internacional C.A. (Caracas) and board chairman of C.V.G. International America, Inc. (New York).—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

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James Loewenberg merged his architectural practice with Marvin Fitch; their combined practice is known as the Loewenberg/Fitch Partnership, Chicago, Ill. . . . **Jerome E. Vielehr** resigned from the Joseph Schlitz Brewing Co. Jerome had been president of Schlitz since April 1980. . . . W.R. Grace and Co., Lexington, Mass., announces that **Edward G. Najjar** has been named executive vice-president, technology and development. Edward and his wife Gail live in Lincoln, Mass., with their three children—Michael, Susan, and Elizabeth, according to class notes gathered at our 25th Reunion. . . . Also promoted by W.R. Grace and Co. is **Robert R. Pollard** to the position of executive vice-president, specialty chemicals unit. . . . **Edward Zoolalian** writes that he is in his 14th year with Neff Instrument Corp., Monrovia, Calif., and that business has been great for the past two years. Ed is also enjoying his second term as city councilman and his new fun home at the beach (Channel Island, Oxnard), one and one-half hour's drive from his home in Monrovia. Ed and his wife Denise have three children—Jim, 15, making movies; Pamela, 14, dancing; and Linda 12, piano. In addition to his work as manufacturing manager for Neff, Ed also has a wholesale supply business which he has run from his home for nine years. Ed attends alumni luncheons at Caltech each month.

In our July class notes we reported that **Jere Shopf** had been promoted to executive assistant to the chairman of the board of Halter Marine in New Orleans, La. Now we receive news of a further change in Jere's life. He has been named president of Halter Marine. Shoph joined Halter in December 1981 as executive assistant to the chairman of the board and was also serving on the company's executive committee and the board of directors. In its announcement Halter said that Shopf's 11 years of experience as a chief executive officer of two major corporations combined with his financial and engineering background will be a major asset to the Halter corporation. . . . **Joseph S. Gaziano** has been named a new director for Heinicke Instruments Co., Hollywood, Fla., a company which makes laboratory equipment and jet engine replacement parts. Joseph is chairman of Tyco Laboratories, Inc., which owns about 46 percent of Heinicke's stock. Joseph and his wife Anne Marie live in Epping, N.H., with their three children—Christopher, a student at Belmont Hill; Cara Mia, a student at Phillips Exeter Academy; and Mary Elizabeth, a student at Berwick Academy. Previous to his present position, Joseph was director of Mobil Tyco Solar Energy Corp.; director, New Boston Garden Corp.; director, Muirhead Ltd.; trustee, Berwick Academy; and trustee, St. Anselm's College.

Ideal Toy Corp. has promoted **Norman Siegler** to the position of senior vice-president, finance, and controller. Norman retains the position as the company's chief financial officer. He has been vice-president, finance, and controller, since December 1978. Norman joined Ideal in 1971 as corporate controller. Previously he was a financial executive with Xerox Gorp. Norman and his wife Marlene live in East Hills, N.Y., with their four children—Robert, 25, M.B.A. June 1981, the University of Chicago, working at Herzog-Heine and Co., in New York City as a financial analyst; Lynn, 23, with a B.A., August 1981, University of Washington; Eric, 20, Class of '84 at M.I.T.; and Ann, 14, in junior high school. Norman is an avid tennis player, is involved in urban renewal programs, sewer projects, and civic associations, and is director of a swim club. He has been a regional chairman on M.I.T. fund-raising committees.

The excellent participation of our group in the fall class telethon somehow went by unreported. **Curt Burrowes** was the class telethon coordinator. He was assisted by **Charles Brattin, James Fleming, George Garfinkle, Arnold Schindler, Theodore H. Korelitz, James Mozzicato, Marge Gilson, Charles B. Hazard**, and **David J. Goldman**. By the time this is in print, the fall telethon will be imminent again. It is a fine work these classmates do. . . . I hope your summer has been a good one, with time for relaxation and visiting friends. Let us know any news of classmates, and if you are out West, at least give your western correspondent a call. Denver boasts one of the busiest airports in the country, so I'm sure some of you are coming through. We'd love to hear from you.—Co-secretaries: **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818; **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345

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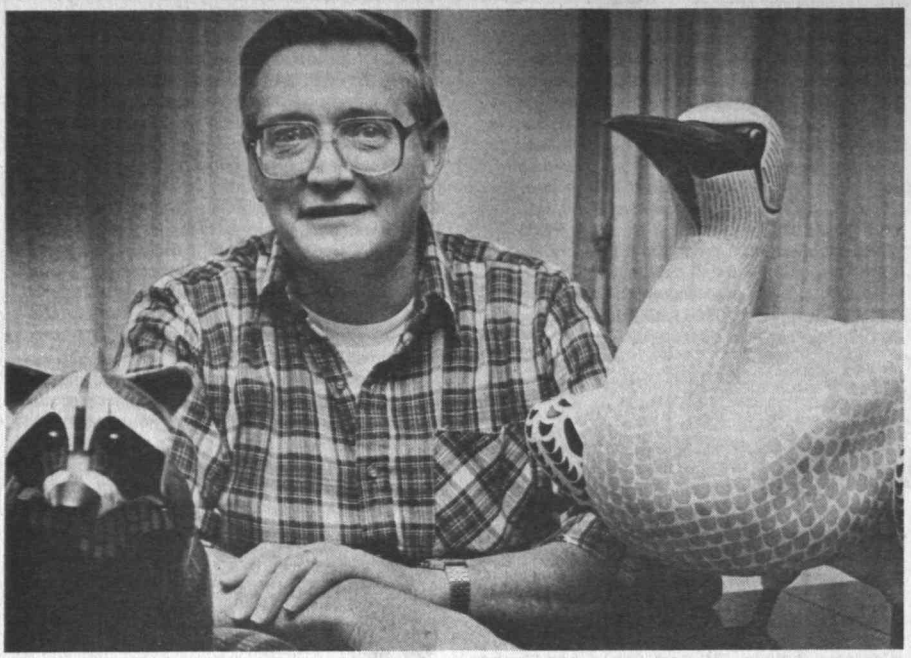
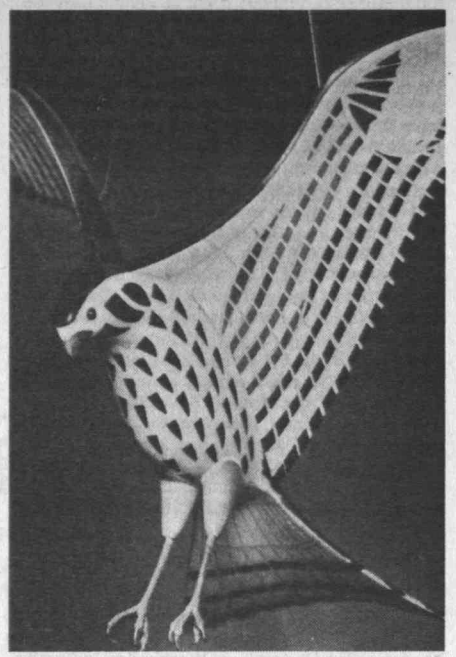
It's been a while since I buckled down and got out the class notes, for which I have been chided by **Pete Silverberg**, who caught me at an M.I.T. Club of Cleveland directors' luncheon. Pete has kindly relieved me of another secretarial duty, that of the Cleveland M.I.T. Club. Pete gave a paper, "Thermal Aging of Synchronous Rotor Poles," at the Electrical/Electronic Insulation Conference last October in Chicago. . . . Under old business, **Roy Waldmann** was last reported to have been a member of the Reagan transition team, but was likely to return to private law practice. By the time that had appeared in print, Ray had been sworn in as assistant secretary of commerce for international economic policy. Ray, are you still there? . . . Besides Pete, these classmates have been presenters of sorts in recent months: David Staelin, who participated in a seminar panel on digital compression techniques in January as part of the M.I.T. research program on communications policy; Robert Kessler, vice-president of the Energy Technology Office, Avco Everett Research Laboratory, who in December led a tour of the laboratory's magnetohydrodynamic electric power generators; and **Susan E. Schur**, who exhibited her paintings in November at the M.I.T. Faculty Club.

Honors have also been coming to members of our class. **Henry R. Piehler**, professor of metallurgy and materials science, and engineering and public policy, Carnegie-Mellon University, Pittsburgh, Pa., was named a 1981 recipient of the Award of Merit by the American Society for Testing and Materials (ASTM). The award recognizes distinguished service to the cause of voluntary standardization through productive service to ASTM, marked leadership, outstanding contribution, or publication of papers. . . . **Bill Booziotis** was a recipient of the 1981 Harold E. Lobdell, Class of 1917 Distinguished Service Award, presented at the last Alumni Officers Conference. . . . And **Barry L. Karger** writes, "I have been at Northeastern University for 18 years and am now professor of chemistry and director of the Institute of Chemical Analysis. I will receive the 1982 American Chemical Society Award in Chromatography. I have two daughters, Bess, 11, and Joanne, 6." . . . **Sheila Evans Widnall**, professor of aeronautics at M.I.T., has been elected to a four-year term on the board of directors of the American Association for the Advancement of Science. . . . **Richard H. Oeler** has been named general manager of the Process Gas Division of Air Products and Chemicals, Inc. . . . **Erik T. Ringkjob** has been named executive vice-president of operations for Storage Technology Corp. . . . **Michael A. Rosner** has been reelected to a three-year term as chief of the Department of Medicine at Holyoke Hospital, South Hadley, Mass. . . . **Edward J.**





"An awful lot of the tools and techniques used by modern science were originally developed by artists," claims ***Charles Saltsman, '52,*** *of Westfield, Conn. Mr. Saltsman speaks from experience, as he is both president of Raymond Engineering and an innovative craftsman. He has created more than two dozen birds and woodland animals in his basement, each made up of close to a thousand interlocking wood pieces.*

Mr. Saltsman invented and perfected the process required to produce these "wood mosaics," as he calls them. He starts with a clay model from which he makes a plaster mold that is then filled with wax. The wood pieces are glued to the wax (which is later melted away) and coated with homemade polyester glue or epoxy. The result is a sleek osprey, gannet, or raccoon in tones of teak, ebony, and other woods that emulate natural animal colorings.

Mr. Saltsman explains, "I can play scientist one day and involve myself with learning about the chemistry of wax or glues, while on the next day I can play artist and enjoy the challenge of working with fine woods." He adds, "Art and engineering are damn close . . . they really are."—Susan Katz (Photos: Peter Kramer, Middletown, Conn.)

Shahady, professor and chairman of the department of family medicine in the School of Medicine at the University of North Carolina at Chapel Hill, has been reappointed chairman of that department. . . . **Barry R. Bronfin**, president of Scientific Leasing, Inc., Farmington, has been elected to the business development council of Old Stone Bank in Providence, R.I. . . . **Tom N. Thiele** has been appointed director of advanced electronic development at the Atlanta, Ga.–based Siemens-Allis, Inc. Tom writes, "Our family, now including wife Mary and four offspring—Mark, 12; Mike, 9; Melissa, 6; and Andrew, 4—are enjoying growing up in the sunny South. Would enjoy hearing from classmates who may be in the area."

Professor **David A. Aaker** of the University of California, Berkeley, School of Business Administration has been appointed to the newly created Shansby Chair in Marketing Strategy. . . . **Joseph A. Verderber** writes, "Beginning October 1, 1981, I was general manager of AM International's ECRM Division in Bedford, Mass., and of an electronic mail venture in Mt. Prospect, Ill. Since January 15, 1982, I have been president of AM's Varityper Division in E. Hanover, N.J. I'm still commuting home to Barrington, Ill., on weekends until my daughter Lisa, 17, graduates from high school in June." . . . **Richard J. Bertman**, architect for Childs Bertman Tseckares and Casendino, Inc., Boston, has been named assistant, Professional Examination Committee of the National Council of Architectural Registration Boards. . . . **Fred Kayne**, a general partner in the investment banking firm of Bear, Stearns and Co., was elected a director of Fisher Foods, Inc., Bedford Heights, Ohio. . . . **Raymond A. Ambrogi** has been named director, product and technical development, in the Consumer Products Division of Corning Glass Works. . . . **Herbert Fox** has been named director of industry and large account sales for Data General.

John C. Schaefer writes, "For the last five years I have run a small consulting business in Palo Alto, dealing mostly with electric utilities and issues of planning, load management, and pricing. Occasionally I do some work in developing countries; last year my two children and I spent four interesting months in Bolivia." . . . **William J. Nicholson** tells us he is now manager of Corporate Energy Services for Potlatch Corp. in San Francisco. . . . Says **Samuel A. Lett**, "In July 1980 I was appointed a professor of pediatrics at Harvard Medical School, where I teach genetics, do cytogenetics research, and direct a prenatal diagnosis lab. This year I am fortunate to be back at M.I.T., on sabbatical working in the laboratory of Professor David Baltimore." . . . That's all for now. We should be caught up by the next issue.—**Noel S. Bartlett**, Secretary, 15320 Edolyn Ave., Cleveland, OH 44111

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I received a nice letter from **Leland Jackson**. Last year he was elected a fellow in the IEEE for "contributions to the finite-word-length design and hardware implementation of digital filters." **Jim Omura** was also elected a fellow. Leland has resigned after two years as department chairman at the University of Rhode Island. He finds teaching and research more enjoyable. His wife Diana is now organist and choir director at a local church, and they have installed a pipe organ in their house. They also are building a cottage on 18 acres of woodland (that's about 7.3 hectares for you metric buffs), and their daughter Anita loves the woods and streams. . . . *Biblical Games: A Strategic Analysis of Stories in the Old Testament* by **Steven J. Brams**, which was published by the M.I.T. Press two years ago, is now available in paperback. . . . **Gordon R. Knight** married Doris Chang in December. He is media/optics development manager at Optimem, a subsidiary of Xerox Corp. . . . **Roger Weissinger** writes that following his Ph.D. at Stanford he taught computer information systems at the University of British Columbia. For the past two years he has been an associate professor at the Naval Postgradaute School in Monterey, Calif. His research is in computer support of military decision making. He has a two year old daughter.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63 20th Reunion

Greetings and salutations. Next year we will be celebrating the 20th anniversary of our graduation from the Institute. It's hard to believe that much time has gone by since our years on the banks of the Charles. If you haven't already marked your calendar, why don't you note the dates of our upcoming reunion, June 10–12, 1983, and make plans to be with old friends in the new Boston.

Now the news. . . . I had a letter from **Woody Bowman**, who says that he is still single but is very impulsive these days, and anything could happen. He is finishing his third term in the Illinois House of Representatives, and is thoroughly enjoying his job. Last year Illinois voters approved a constitutional amendment reducing the size of the House by one-third. Woody could have been wiped out, but he wound up with a good district to

run in. He says he faces a stiff challenge from his Republican opponent, another incumbent. Chicago, where Woody lives, has recently adopted a method of voting which uses computer punched cards, and the *Chicago Tribune* published a short editorial which asks the hypothetical question, "Will ward heelers of the future have to go to M.I.T. to learn how to steal votes?"

David Marks writes to say that this past May he built a reinforced concrete beach house near Orient, Long Island. . . . Various news releases inform us that **Ed Dudewicz** was elected a fellow of the American Society for Quality Control. He was recognized at the annual honors and awards breakfast last May in Detroit for his distinguished service to the society and for his contributions to the science of quality control and statistics. Ed has been professor of statistics at Ohio State University and will be developing a statistics program at Syracuse University this fall. . . . **John Scott** was elected to the National Academy of Engineering in February. John is vice-president of process research at Chevron Research Co. in Richmond, Calif. He was honored for his work in the conception and management of modern petroleum hydrocracking technology. . . . A news article from the *Brattleboro* (Vermont) *Reformer* tells us that **John Wasserlein** has been promoted to a vice-presidency at Boise Cascade Corp. John is general manager of the company's specialty paperboard division in Vermont. John has also been active on the Brattleboro Union High School board and served as president of the Brattleboro Memorial Hospital board of directors.

In the better-late-than-never department we mention that, last November, **Peter Anderson** made a presentation to an IEEE group in the Boston area. Peter's presentation was on the "design and performance of an equalized modem for HF radio."

Well, that's all there is, folks. More next month.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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It seems hard to believe that a year has passed since we were at our 15th Reunion. . . . **Paul Rudovsky** ran (and finished) the Long Island Marathon averaging under nine miniutes per mile. . . . Paul and **Larry Schwoeri** chanced upon each other while running in Central Park. This led to brunch and a pleasant visit. . . . **Ira Davidoff** and his wife, the former Martha Snider, are both physicians in California. He is an internist and chief of medicine at the local hospital, while she is chief of pediatrics at a Kaiser Foundation hospital.

Bernard Mathaisel has been elected a principal of Temple, Barker, and Sloane, a consulting firm in Lexington, Mass. . . . **Harry Davitian** has formed his own consulting firm, Entek Research, Inc., specializing in supplying technical analyses to utilities. Harry is married to the former Carlene Bryant. They have one child.

The Mansfield, Mass., high school wanted to start a program where business leaders would come in and discuss topics of interest with the students. The *Mansfield News* reports that the first volunteer was our classmate **Richard Jastrem**, now a certified public accountant. . . . **James Carroll** is manager, Aerospace Sciences Division of Scientific Systems, Inc., in Cambridge. The Carrolls have two small boys and enjoy spending time in Maine. . . .**Richard Williams** says he is running more, studying Japanese, and planning to change his single ways out there in Hawaii. . . . **Barnet Wolff** runs his own software consulting firm, Databus, Inc. The Wolffs had their third child, a daughter, just before New Year's Day.

Judy and **Matthew Fichtenbaum** wrote while still expecting their first child. Please write again and let us know the outcome; the suspense is killing me! Matt writes that he has added contradance fiddle to his repertoire. He is a senior principal engineer with GenRad in Concord, Mass. . . . **Jim Deckert**, one of the first of our class to actually write to me with news after I became class editor, is currently a section chief at the Draper Lab. Jim works on applying fault-tolerant system concepts to commercial power plants. . . . I received a note from **Robin Moore**, who has recently joined the faculty of Landscape Architecture at the School of Design, North Carolina State University. Robin has written a book on the use of the local environment by children.

On a personal note, Theresa and I spent a delightful weekend recently with Eileen and **Walt Shedd**. They flew down from Acton, Mass., in the plane they own in partnership with **Dave Tweed**. This completes my first year as class editor. I am enjoying it, but I am concerned about the shortage of news. My backlog is now zero! If you want to see news, you have to write. Please do—no one is ignored.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Fort Salonga, NY 11768

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The news is brief this month. Please write. **Richard Cunningham**'s family now consists of seven children: three boys, and four girls. Richard is presently on the Connecticut State Central Committee. . . . **Carl Kalinowski** is living in New Brunswick, N.J., and working in sales for Digital Equipment Corp. . . . **Guillermo Arnaud** finished medical school at the University of Maryland last May, and has begun a general surgery internship at the University of Maryland Hospital in Baltimore. . . . **John Broadley** was recently appointed general counsel of the Interstate Commerce Commission after serving the past year as chief counsel of the Federal Railroad Administration. He resides in Bethesda, Md. . . . **Marc Levenson** is a staff member at the IBM Research Division Laboratory in San Jose, Calif.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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My publishing activities are slowly moving foreward. *The Silver Mistress* is finally out, a year and a-half late. I've also joined a friend in his publishing company, Donald M. Grant, Publisher, Inc., which has just put out a new Stephen King hardcover and has five more books scheduled for this year.

Our class president, **Mel Basan,** reports that he is still working as an attorney for the NLRB and is kept pretty busy as he also was "foolish enough to become president of a 188-unit condominium." . . . **William P. Bengen** continues to find his position with a family soft drink firm (7-Up franchise for five counties) an exciting challenge, as the industry is in a period of dramatic upheaval and realignment. His daughters, Jenny (2) and Christy (3), are a joy and occasional tribulation! . . . **John Gruenstein** and his wife Carolyn are kept busy with their children, Cassie (6) and Alex (2), and their two cats. John received his Ph.D. from the University of Pennsylvania and is currently working on local economic development in the Philadelphia area. His current major project is designing and implementing a high technology business development zone in West Philadelphia. . . . **Victor Caliandro** is now an associate with Cooper, Ecksnt Associates and is project manager and designer for the esplanade at Battery Park City. . . . **Richard L. Mazer** is now vice-president of Gelco Rail Services. . . . Dee and **Thomas Inrick** are looking forward to the sailing and skiing in Seattle, where Tom works for the Flight Standards Division of FAA Northwest Region and is participating in the DOT's Executive Development Program (a two-year part-time management training program).

Russel T. Brock is the manager of the Systems Performance Department at TRW, which includes software development for missle and space applications, color graphics applications, and artificial intelligence. . . . **Edward M. Waibel** is currently serving as interim president and general manager for Avicon Corp. in Addison, Tex., a small manufacturer of microprocessor-based engine-monitoring computers. . . . **Michael W. Laird** covered a lot of miles last year. He reports: "During the early part of the year, I commuted weekly from New York to Boston to complete a project with the MDC. For the summer, my wife and I moved to Caracas, Venezuela, to work on another project. We then spent a month vacationing throughout South America. We later spent a week in Copenhagen and Stockholm to consider a job transfer there. After all that exotic travel, I'm now commuting weekly to Pittsburgh for another client project!" . . . On a recent trip to San Francisco, Barbara and **W. H. (Tom) Thomas, Jr.** lunched, with Nancy and DuBose Montgomery, '72, and spoke with John Garth, '70, just before leaving. **Greg Kast**, another former M.I.T. Golf Team member, was off to Hawaii after Tom told him he would be at Berkeley for a golf match.

Finally, I'm sorry to report the death last year of **Paul D. Birnbaum**, the seventh member of our class to prematurely pass away. . . . Please keep me informed of your activities.—**Robert K. Weiner**, Box 27, M.I.T. Branch, Cambridge, MA 02139

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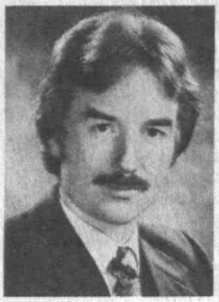
Late Summer Greetings. **Karen W. Arenson** has been awarded the prestigeous Matrix Award, which recognizes women for outstanding performance in certain areas of communications. The New York Chapter of Women in Communications, Inc. has given Ms. Arenson the award for her financial and economic reporting for the *New York Times*, and she has recently authored the *New York Times Guide to Making a New Tax Law Work for You*. . . . **Roderic S. Walker** is currently managing the Chicago office of American Management Systems. He provides management consulting and software services to larger operations and governmental bodies. . . . **David E. Sheldon** is working for TRIAD Systems as regional marketing representative from northern California. . . . **Michael J. Hoffman** is now an assistant professor with the Department of Mathematics and Computer Science at California State University at Los Angeles. . . . Mrs. **Elaine Gruber** is a CPA and has joined Bendix Corp. as an accounting analyst. . . . Software Arts and its main product, VisiCalc, is continuing to do well, according to **Robert Frankston**, who resides in Newton. . . . **Howard Hoffman** is a senior engineer and member of the corporation of Kennedy/Jenks Engineers, a leading engineering consulting firm. He also has become active in racing Hobie Cat sailboats.

Gary Rochelle has been promoted to associate professor of chemical engineering at the University of Texas at Austin. . . . **Robert J. McKinley** recently has been active in the alumni fund's telethons. . . . **Charles Lieberman** has a rewarding and satisfying career as an economic forecaster and writer for a weekly economic report for his clients in Morgan-Stanley. . . . **Michael Jennings** is an assistant professor of physiology and biophysics at the University of Iowa College of Medicine. . . . **James Stone** is currently teaching in the Fine Arts Department at Boston College and is writing his second photography textbook. Classmates in the Boston area should contact him concerning showings of his photographs.

Mark Bishgeier is an entertainment attorney in Beverly Hills. He has been involved in the production of *Superman* and *Being There*. . . . **Ronald Stoltz** left Sandia Laboratories in San Francisco and is now working at the corporate research labs of Exxon. He is now group head of surface metallurgy and has two children, Mitch and Greg. . . . **Steven Terry** is one of the co-founders of a new high-technology company, MicroSensor Technology, Inc., in Fremont, Calif. Their major product will be minature gas chromatographs fabricated on silicon wafers. . . . **Howard Manasse** has finished his fellowship in retina/vitreous surgery and is practicing in Erie, Pa. . . . Marcia and **Michael Levy** have a daughter and are now living in Columbia, Md. Michael is working for the National Institute of Health and Radiation Safety and is pursuing a degree in clinical engineering at Johns Hopkins. . . . **Anthony Picardi** is developing a simulation model of the U.S. economy, based upon the systems dynamic model development at the Sloan School. He is doing this work at Manage-

ment Technologies, Inc. in Wellesley. And his wife, Shirley, has started a new job as secretary of M.I.T. Alumni Association. They have recently traveled in Switzerland, the island of Majorca, and the British Virgin Islands.



Steven Kruger, '70

J. O. Enwonwu is principal consultant for Enwonwu Associates in Nigeria. He is also president of Architectural Heritage Construction Co. and chairman of Nigeria Heritage Regency Hotels, Ltd. . . . **Jeffrey Sagarin** boasts of being the nation's leading mathematical sports handicapper, with his predictions appearing in the *Boston Globe* and other places. He is also working on a doctoral business degree at Indiana University School of Business. . . . **Reid Ashe** is the editor of the *Jackson Sun* in Tennessee. . . . **Louis Reich** is presently a lawyer with the Securities Exchange Commission in Washington. . . . **Steven A. Kruger** has been named head of the management information consulting practice of the Rochester office of Arthur Anderson and Company. Steven is a CPA, and after graduation from the Institute received an M.B.A. from Wharton. He has published various articles and participated in various seminars. . . . Wayne State University announced that **David Njus** has been elected a fellow of the American Association for the Advancement of Science. He has conducted basic scientific research in the biophysics and biochemistry of membrane function. After graduation, he received a Ph.D. from Harvard and did postdoctural work at the University of Oxford, England. . . . **Stanley Goldin** has received several awards recognizing his work on transport proteins and is presently at the Harvard Medical School as an assistant professor of pharmacology. He has been named the McKnight Foundation Scholar and has received the Searle Award and the Alfred P. Sloan Award for research in neurosciences.—**Robert O. Vegeler**, Secretary, Dumas, Burke, Backs, Salin, and Vegeler, 2120 Ft. Wayne National Bank Bldg., Fort Wayne, IN 46802

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Thomas R. Smith announces that his wife is expecting their second child, who will join their 2-year-old daughter, in September. He has been the head of the math department at the Park School, Brookline, Mass., for five years. . . . **Romek Figa** is living in Quincy, Mass., with his wife Gail and two children. He is working for New England Telephone as a systems analyst and is working to make Jesus Christ the lord of his life. . . . **Hugh H. Sprunt, Jr.** has two children—Elsa Dumbar, born July 26, 1981, and Alexander Dalziel, who is 4 and in preschool. Hugh is a CPA attorney doing tax work. His wife Eve is still a senior research geophysicist for Mobil research and development. . . . **H. Carey Probst** is regional planning services manager for Management Decisions Systems, Inc. for the metropolitan New York region and will be moving into a new log home he designed and built in Morristown, N.J. He is interested in contacting others from our class or PKT in the area.

Ronald Ort is back into chemical engineering for Martin Mariett at their alumina plant in St. Croix, Virgin Islands, after six years as a patent attorney. He'd love to hear from any friends who come his way. . . . **Kerry R. Mull** has been working for SBS in McLean, Va., since February 1981. His wife Katherine was expecting their first child in April 1982. . . . **Ah-Poh Yao** is looking for **Gus Vlahakes**. Ah-Poh is now in Canada after ten years in Singapore, Malaysia, with Mobil. He is now with Alberta Energy Co. in the company's investment program, arriving in Canada during the coldest part of the winter. His address is: Alberta Energy Co., Ltd. 2400, 639 5th Ave S.W., Alberta T2P Ontario. . . . It is my sad duty to announce the death of **James W. Haffner.**—**R. Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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Greetings to the faithful.

Lee Giguere, the old Sig-Ep Maino who kept *The Tech* going for a while, dropped me a note from (of course) a newspaper, the Manchester, Conn. *Journal Inquirer*, where he is wire editor. The "JI" is putting in a computer typesetting system this summer, which Lee raves about for its flexibility and ease of use for reworking wire service copy. Wife Gina had a baby girl December 22, and he notes having missed *The Tech*'s 100th, but after reading in *Technology Review* about it, wishes he hadn't.

Doug Levene writes from New York where he has moved (from Ann Arbor) to clerk with Judge Lumbard on the 2nd circuit. He also admits to becoming a "confirmed New Yorker," which is hard to believe—not only for New York being what it is but because I remember him actually liking Ann Arbor, which resembles New York as much as the MGM lion is like my Aunt Grace. He will, however, make it closer to God's country next year when he moves to Washington to clerk for Chief Justice Burger. Doug is dating several girls between 17 and 26, which he says makes him think there is life after 30. Now I am over 30, my babysitter is 17, and my sons are 8 and 1. Them's must be some faaaast girls up thar!

The ever-youthful **Tom Stagliano** has the M.I.T. Community Hockey League going again. They scrimmage groups at Harvard, Boston University, and Boston College as well as a men's league in Winchester, Mass. They are in their 6th season with the Bay State League with three seconds and two firsts to date.

Tony Scandora was here on his way back to Chicago from the Atlanta computer convention (DECUS) in May. Nothing new to report there. . . . And Ruth and I have closed on our 13 acres in Fauquier County, on which we'll build when our house sells. Y'all write now!—**Bob Sutton**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

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David F. Barker recieved a Ph.D. in molecular biology from Stanford University in October 1980. Currently he is an NIH postdoctoral fellow at Howard Hughes Medical Institute at the University of Utah Medical Center, working on human molecular genetics. . . . **Thomas Olsen** was expecting to receive a Ph.D. in physics from the University of Southern California last June. "My exile in Los Angeles will probably continue (as a postdoc) for the following year. I've also had the privilege of teaching the college and career Sunday school class at my chruch." . . . **Windsor Sung** received a Ph.D. in environmental engineering sciences from Caltech in 1981. "My doctoral thesis, under the direction of J. J. Morgan, won the 1981 AEEP-NALCO award for significant chemical research in water and wastewater treatment. The award was presented to me on October 5, 1981, at the annual WPCF meeting in Detroit, Mich. I have been married to Marilyn Ho since the summer of 1978; we reside in Durham, N.H. I am an assistant professor of civil engineering at the University of New Hampshire. Would like to hear from Tau Epsilon Phi members from the Class of 1975." . . . **George Gerpheide** reports: "After taking a year off to engineer a computer-managed indoor golf game ('Par-T-Golf'), I finally completed my Ph.D. in computer science (University of Utah, June 1981). Then cofounded Aquila Instruments, Inc.; we developed and are currently producing induced polarization (IP) receivers for geophysical survey work. Currently designing microprocessor based equipment on a custom basis. Spent a large part of last winter skiing the exceptionally steep-and-deep; the snow looks like it will last most of the summer here. Plan to stay in Salt Lake City."

David Olive is currently a third-year resident in obstetrics and gynecology at Northwestern University Hospitals. . . . **Ralph Martin** started a practice in internal medicine near Worcester, Mass., in July 1982. . . . **John Eidinger** reports that he is again working in San Francisco at EDS, coordinating European office activities. "This gives me a great chance to play in the 'balance of the world.' To keep out of trouble, I am pursuing an evening M.B.A. at Berkeley, ski a lot, and remain deeply motivated in Asian activities." . . . **Alex Pankow** married Susan Longo, a graduate of Ohio State, on August 22, 1981. "We spent 15 days on our honeymoon in Portugal and Spain. I started a new job in October 1981 as a project manager with General Electric Information Services Co. in Rockville, Md. I spent two weeks in October in England working on one of GEISCO's new information system products." . . . **Paul E. Clift**: "I am now vice-president, technical services of SIMPLAN Systems, Inc., a software firm." About a year ago he had a son, Aaron David Clift. . . . **Yaw Yeboah** is a research staff chemical engineer at the General Electric Corporate Research and Development Center in Schenectady, N.Y. . . . **Lila Kobylak Kung**: "The children are both attending school now. I have returned to work and am a program engineer for Lockheed. I am thinking of returning to graduate school."

Most of the notices I received are handwritten. By and large I would say physicians have the smallest handwriting, while architecture majors have the most beautiful. I have gotten two or three notices that were printed using fancy computer typesetting equipment (Xerox 9700 or similar). That's going a bit too far; but I liked getting one from **Tom McKim** that was done on an Apple II Plus: "I am still practicing law in Washington, D.C. with the firm of Jones, Day, Reavis, and Pogue. I've begun to develop a specialty in litigation that focuses on computer technology, although I have also been involved quite a bit in providing antitrust counseling to banks that are implementing electronic funds transfer networks. . . . I have implemented a number of computerized litigation support systems. Traveling on behalf of clients has enabled me to keep my commercial pilot's license and instrument rating current. . . . So far I have found being a lawyer quite a bit of fun!"

Thomas Covell received a master of architecture from Washington University in 1977. He lives in Madison, Wis., with his wife Beth Jorgensen. He is working with Flad and Associates as a project architect and designer, mostly on hospital projects. . . . On May 1 **John Maurer** married Adele Castrovilla, who was a graduate student in aeronautics and astronautics at M.I.T. from 1977 to 1979. "We will live at my place in Natick through September, then move into a larger apartment. Any friends are naturally encouraged to look us up." . . . **Leonard DeRoma** was married to Mary Bellisario March 20 in St. Patrick's cathedral in New York. . . . **John Robert Stiehler** was promoted to candy buyer at Nieman-Marcus. . . . Lieutenant **Jeffrey Schweiger** is due to gradaute from the Naval Postgraduate School on October with a master of science in systems technology. He is doing his thesis in the area of geomagnetics. . . . **Jeffrey Star** is "spending the year at the University of California at Santa Barbara . . . and out on the *R.V. Endeavor*, a 175-foot research vessel owned by the University of Rhode Island. Sixty-six days at sea this year, zero planned after that!" He sends regards to everybody. . . . Mike and **Martha Donahue Callaway** "are proud to announce the birth of Cristopher Donahue Callaway (5 pounds, 13 ounces, 20 inches) on December 3, 1981. As a result," says Martha, "I chose to get out of the Air Force (staying in the reserves) and am now a 'domestic engineer.' Mike was reassigned by the Air Force to California, so we moved there in June."—**Alex Castaldo**, Secretary, 929 Mass. Ave. (12D), Cambridge, MA 02139

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The mails continue to be kind to your hard-pressed secretary. From **Debby Stein Sharpe**, "Am settled in Motown, working hard as manager, new products, for a small manufacturer trying to branch out from the automotive arena. Jim and I are adjusting to the flatlands and the midwestern mindset, while anxiously awaiting the arrival of a new family member—a very small kitten." . . . **George M. St. George** writes, "I should have my Ph.D. in chemistry from the University of Illinois by the end of November. Then I'll be working for Dow Chemical in Houston." . . . And **Robert Winkler** reports, "Currently associate professor of naval science at Texas A & M University, teaching freshman naval science. I am working toward my master's in computer science at Texas A & M at the same time."

Gordon Fulton has six years with Shell Oil Co. He designs data communication networks for the company. His hobbies include singing in a gospel quartet, piano, and tennis. . . . **David Kates** received his master's in electrical engineering from M.I.T. in February 1982 and is employed at H.P., Andover, Mass., in the Medical Electronics Division developing research tools for ultrasonic imaging devices." . . . **Richard Winters** is in his second year of internal medicine residency in Lansing, Mich. . . . **Richard Radville** is "currently a staff architect at the Architect's Collaborative in Cambridge, involved in the construction of a large corporate office building in the Hartford, Conn., area." . . . **Clifford Grimes** was transferred to Dallas and is now an applications development engineer, but is still with Schlumberger Well Services. He says, "We're living in a Dallas suburb and are enjoying the change from the Panhandle."

Wendy Peikes has sent an interesting note. "I've been back at M.I.T. quite often lately—Hewlett Packard sends me there twice a year to recruit. As a recruiter and engineer, I can truthfully say that I am impressed with the quality of the students I have interviewed. I placed quite a few M.I.T. people in permanent and summer jobs, and I hope to continue doing so. And Boston, as always, is a beautiful place to visit." . . . **Gregory Hunter** is finishing up his fifth year as high school mathematics teacher and coach. He says, "I really enjoyed teaching but will try my hand at something different in a year or two (like making money)." . . . **Christopher Kapral** is "the GTE representative in the Silicon Structures Project at Caltech." . . . And from **Monique Plante**, "I am happy to announce my impending marriage to Michael M. Lieberman on August 1. First year of law school is wrapping up! Sales of Corning Electronics are better than ever. As usual, I would love to hear from old friends." . . . **Hillary Morgenstern** was awarded the doctor of optometry degree from the New England College of Optometry. While there, she founded a fitness class at NEWENCO and organized a student council.

We have an author in our midst. From **David Stork**: "My first book, *The Physics of Sound* (Prentice Hall), appears in January. (Is this our first class book?) My second, *Seeing the Light* (Harper and Row), is coming along but slows my research and dissertation progress. Nonetheless, I expect to graduate (Ph.D., University of Maryland) in May and take a postdoc posiition in the Laboratory of Visual Perception, SUNY, Buffalo." . . . Your secretary had two phone conversations with classmates. First of all, **Alan Swide** has effectively completed his M.B.A. at Columbia's Center for the Study of Futures Markets and now is doing arbitrage trading (a special form of the spread trading your secretary does) at Bear Stearn in their Water Street offices. From a business point of view, Alan and I are life and death competitors. As it is said, we take no prisoners in the commodity trading pits. Even so, we also remain quite friendly.

I also had a chance to chat with **Mike Sarfatti**. Mike is still working at Standard Oil of California and enjoying it. He also remains deeply attached to California and its pleasant life-style. However, he has not had much contact with classmates over the last few years. He is, I believe, listed in the San Francisco phonebook, if any of you are out there and would like to get in touch with Mike. . . . And, of course, I would appreciate it very much if more people were to write or call me with news. Don't be shy. As for your secretary, he is writing this column with a glass of very old sherry at hand. It helps calm him down a bit. These days he has been trading a lot, especially British pounds, D-marks, bonds, T-bills, pork bellies, and heating oil. However, he also has a fist (not a finger or hand) in virtually every other commodity market. In the process of doing this, he has picked up a nickname at Merrill-Lynch, "Genghis Carp." And I must say I relish the tension. As a matter of fact, I have found that I am addicted to it. Remember, please write or call.—**Arthur J. Carp**, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014, (212) 741-3023

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As I write these notes to you, I am winging my way home from a marvelous vacation in the Pacific Northwest and wishing I could attend our 5th Reunion next week. Once again we have plenty of news! . . . **Mox Tan** sends a very nice card catching us up on his past five years' activities. Mox worked for the New Jersey Environmental Protection Agency for four years and was so impressed with law as a tool for change that he quit work and has now finished his first year at Harvard Law School. Mox will be at an international banking firm, Kelley, Drye, and Warren, this summer in Manhattan. . . . **Deborah Stutman** is currently in the chemical engineering Ph.D. program at Lehigh University and is affiliated with the Emulsion Polymers Institute. . . . Lieutenant **Walter H. Goodwin** has left the Air Force after five years as an operations research scientist and is now attending law school in Detroit. . . . After a period of study at Princeton Theological Seminary, **William T. Yeager** is now a systems programmer at the NOAA Geophysical Laboratory in Princeton. . . . **Alberto C. Sadun** is still at M.I.T., pursuing his Ph.D. in theoretical astrophysics.

Elizabeth Ramirez is graduating from the University of California at San Francisco with an M.D. and from U.C./Berkeley with a master's. Elizabeth is getting married to Philip Pusey, a computer programmer from Birmingham, England. . . . **Charles ("Chip") Moss** has been working for Rocketdyne in Los Angeles since graduation and will be moving to Jerusalem this summer to work for the aircraft industry in Israel. . . . **Dan Fairweather** is married and has a daughter, born in June 1981. He and his family have purchased a home near Lapeer, Mich. . . . **Kathleen Mensler** has finished her master's degree at Berkeley and is now "working for a great company, Molecular Design Ltd.," which sells chemical software from their home base in Hayward, Calif. Kathleen is still living in Berkeley and "enjoying it—it's a crazy place!" . . . **Richard E. Stone** received his Ph.D. in operations research from Stanford in June 1981, and is now an assistant professor at Harvard Business School.

Howie Boles is currently working as a programmer at Applicon and playing the French Horn with the Belmont Symphony. Howie still hopes to make it big on Broadway someday but in the meantime will be getting married on June 13, 1982, in Woodbridge, Conn., to Lisa Podoloff. . . . **Alan Siggia** has been a staff engineer at M.I.T.'s Weather Radar Unit since 1977 and will have begun an M.S./Ph.D. program in Course VI in February 1982, continuing his independent consulting as well. Alan married Ginny Powell (Wellesley '74) on April 21, 1979. Alan and Ginny live in Arlington, Mass., with their cat, Rosebud. . . . **Wendy Irving** is currently enrolled in the master's of architecture program at the University of Colorado at Denver and spends her spare time "hiking and birdwatching, skiing (of course), and just generally taking in the good weather. . . . **Jeff Swalchik** attended the University of Miami School of Medicine, getting his M.D. in 1981, and is now doing his internship with the Navy in San Diego, Calif. Jeff married Lydia Krueger of St. Petersburg, Fla., in May 1981 after a year off at Spacelabs, a medical instrument firm, as a project engineer and technical specialist.

Rick Ulene has returned to the University of Southern California School of Medicine to continue his medical training. **Andrew Werber** received a dual Ph.D. in October 1981 from the neuroscience program and the Department of Pharmacology and Toxicology at Michigan State University. Andrew is now a postdoctoral research fellow at the University of Iowa, at Iowa City. . . . **Renan Beckman Wills** graduated in June from Johns Hopkins School of Medicine and is now an intern at the University of Maryland Hospital. Renan married Bob Wills, a fellow medical student, last May in Rye, N.Y. . . . **Katrina Wooton** was one of Renan's bridesmaids; **Bob Scalea** and Douglas Johnston, '76, also attended the wedding. . . . **John P. Yangos** is now technical director of Apple Computers' distribution center in Greece, after spending three years at the Hellenic Air Force Technical Research Center setting up the digital systems lab.

Lieutenants **Ron Pirek** and **Linda Kerley Pirek** have been doing their respective Navy tours in Alexandria, Va. Ron directs material test programs for reactor plant materials; Linda has spent most of her time with computers. They will be leaving the Navy and the Washington, D.C., area for better climates next summer but aren't certain of their destination yet. . . . **Joseph Combs** recently spent three weeks in Greece on holiday with his wife, Sally Wick. Joseph is a consultant for Xerox Computer Services Division based in Chicago, but spends approximately 50 percent of his time in the Minneaspolis/St. Paul area. . . . **Lisa Dickinson** recently attended a lecture by Sally Zuckerman, sponsored by the M.I.T. Club of Great Britain, and met many other alumni. Lisa is now an educational counselor interviewing students for M.I.T. She said the club is being reenergized through the efforts of Geoffrey Norton, Sloan '81.

Thanks for writing; keep up the good work! That's all for now—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Hello again, faithful friends and readers! (Lousy writers, but faithful readers.) News from all over this month. **Geoff Brooks** is in Pretoria as director of Louis Heyl Associates. His duties include corporate strategic planning and techno-economic analysis. . . . **Marvin Chartoff** is in Vienna—but Virginia, not Austria. Marvin graduated from Carnegie-Mellon's Graduate School of Industrial Administration in May of this year and is now in GTE's Marketing Associate Development Program. His first assignment is with GTE Telenet. . . . **Thomas Theirkauf** is in strategic planning at Hartford National Bank. . . . **Jose Fernandez** is spending one year at Mass. General Hospital doing medical research; then he'll go back to New York University School of Medicine to finish up.

Meredith Warshaw writes, "I've made my yearly change of field and am now studying clinical social work at Bryn Mawr College, near Philadelphia. The area is beautiful but very isolated, and I'm suffering culture shock. No one here understands 'intuitively obvious' or 'order of magnitude,' and everyone is scared of math!" . . . **Zafar Khan** stayed in Cambridge after graduation working as a communications designer at Intertel, Inc. and enjoying Harvard Square. Zafar is now in Sunnyvale, Calif., where he is a communications systems designer at Amdahl Corp. . . . Also in Sunnyvale is **Sandra Viarengo**, who works for Intel Corp. in a wafer fabrication facility responsible for 2732 A EPROM. . . . **Fort Felker** is working for NASA at Ames Research Center, just south of San Francisco. Says Fort, "My research is on the aerodynamics of rotorcraft. I've published a couple of NASA papers, and I'm working on two more. Many of my friends from M.I.T. are in the San Francisco Bay area, including **Steve Tufty**, Fen LaBalme, **Gerry Seinton**, **Debbie Lerman**, Steve Larsen '80, Gregg Aldisert '81, Rich Loose '80, **Leslie Chow**,

Frank Fay, and many others."

Paul Thompson spent two years at the University of Chicago Graduate School of Business, and now works as a financial analyst for Northwest Industries, Inc. in Chicago. Paul got married last October and now lives in Bensenville, Ill. Congrats! . . . More congrats to **Mark Schwartz**, who married Sharon Simon (BU '79) on July 1, 1979, and was expecting their first child this past April. Mark received a commission as second lieutenant in the Air Force after graduation and worked at Draper Lab until reporting for pilot training in Mississippi in April 1980. He graduated pilot training and was awarded his wings in April 1981. (Seems like April is a big month for Mark!) Mark was assigned to fly F-4 phantom fighter jets and is now in Florida for training. . . . **Mark Sylvester** got his S.M. from M.I.T. in October 1981 and is working at the 'Tute as a research associate for a few years before returning for a Ph.D. On August 29, 1981, Mark married Lydia Equitz (Wellesley '81), who is working on a master's at Harvard. Writes Mark, "I got my picture in *Time*, *Discovery*, etc. for my work on the artifical skin project. I had my plane tickets to Stockholm, but they never called!" Oh well, better luck next year.

Russell Steinweg completed his M.S. in computer engineering at Stanford, and is now at Burroughs Corp. in Mission Viejo in sunny southern California. He says, "I am living in exclusive, yet fun, Newport Beach trying to figure out how to spend my over-inflated salary and loving every minute of it, for the social life is fantastic. Fortunately, Burroughs was impressed enough with my background and leadership potential that they brought me in at a higher position—and much higher salary—than usual. You'd think I went to M.I.T. or something!" . . . **Aldo Spadoni** is currently living in Manhattan Beach and working for TRW, troubleshooting inertial instrument anomalies for the MX missile guidance system. Aldo writes, "I've just started designing women's clothing for a California-based silk importer. It could be significantly more profitable than engineering. I participated in an all-night wild party at Edwards Air Force Base on the eve of the first shuttle landing. Sure was great to be there!"

Claude Von Roesgen gets around. Claude and **Jimi Parks** bicycled cross-country last summer. Claude writes, "We left Porter Square on June 16 at noon. First stop was Fresh Pond for lunch at BBN, my former employer. On Labor Day I arrived at Haight-Asbury. It took me a week to recover! I visited Sue Verba and Tamas Eger '77, Milan Momirov '77, Peter Cheimets '78, **Lenny Sherman**, Tom Durgavitch '75, Elaine Sears, and Ed Shaing, all of whom are enjoying themselves on the West Coast. In Australia I visited **Catherine McCammon**, who is now at the Australian National University." . . . I ran into **Bob Hull** in the most unlikely place recently: at St. Bartholomew's Church here in New York, where I was in *Annie Get Your Gun* with the St. Bart's Players last fall. I was working on costumes and spotlights for their spring musical, *Hello, Dolly*, and discovered that Bob was one of the cast members! Bob has been in New York for the past two years, picking up various acting jobs while he waits for that big break. Also pursuing an acting career, he reports, is his former Shakespeare Ensemble cohort **Jim Walker**.

By the time you all read this, I will have started a six-month assignment in Chicago in the Treasurer's Department of Container Corp. of America, one of Mobil's subsidiaries. For the four or five of you who are planning to write, keep writing to me at this address, as all my mail will be duly forwarded. To the rest of you—stop being so lazy and drop me a line right now!—**Sharon Lowenheim**, Secretary, 131 E. 83 St., Apt. 2G, New York, NY 10028

80

I have just attended my fifth consecutive M.I.T. Commencement, and was amazed to see some of the people who were graduating. It seems like just yesterday when I was giving some of them R/O week tours. Also among the graduates were many familiar names and faces from the class of 1980. More on them as reports roll in.

Congratulations to **Michael Sider**, who will be married to Gail Buchholtz on August 22 in New York. Michael is currently working in New York City as a project manager in data communications for Allied Stores Corp. Michael and Gail plan on honeymooning in Israel for two weeks. . . . **Jeff Rydant** is a graduate student in chemical engineering at the University of California in Santa Barbara. . . . **Jay Chung** is finishing up his second year at Harvard Medical School and is involved in the HST program. . . . **John Wojahn** is at undergraduate pilot training in the U.S. Air Force flying T-38 Talons. He is hoping to get an F-16, go to test pilot school, and continue on to NASA. . . . **Max Blosser** is involved in research on high temperature structures at NASA's Langley Research Center. . . . **Bruce Chung** writes that he and **John Borland** took a bicycle trip last summer from Detroit to San Francisco! "It took 40 days, but was worth every minute." In San Francisco they saw **Chuck Klaniecki**, who works for Magatest. John remained in Silicon Valley to work for National Semiconducter. Bruce flew (getting lazy, Bruce?) back to Detroit to attend Wayne State Medical School.

William Warner has been collecting awards from the American Institute of Architects (AIA). In the past few years he has won the 1980 R.I. AIA Honor Award for the Norman L. Watkins Laboratory at the University of Rhode Island's Graduate School of Oceanography, the 1981 Silver Medal and Investiture to the AIA College of Fellows awarded for outstanding design bestowed by the AIA at the national convention in Minneapolis, has been named a member of the 1982 National AIA Design Committee, and was a recipient of the R.I. AIA President's Award for 1981. In addition, William has been selected for the 1982 edition of *Who's Who in America*, and was a 1982 Visiting professor at M.I.T., and at the Rhode Island School of Design in 1979, 1980, and 1981. Congratulations on these multi-accomplishments!

It's tough to follow up an act like that. Since my last column, I have changed jobs within Bolt, Beranek, and Newman. My new job challenges me as much as my old one, and has an added dimension of responsibility. More on this some other time.—**Ken Turkewitz**, Secretary, 3 Winslow Rd., Belmont, MA 02178

81

There's a certain pattern (or should I say an aura?) to all the responses I receive from our ranks currently located in southern California. Our classmates do seem to be enjoying the mellow, hightech way of life. You can get sunburnt from just holding the letters too close. **Anita Bliss** writes that she is "enjoying the Silicon Valley lifestyle and is working in product development at Shugart Associates," a division of Xerox making disc drives. . . . **John Wenn** is also working at Xerox, and works with VLSI software tools. . . . **Matthew Thompson**, who is working on his master's in mechanical engineering at Stanford, has taken up aerobatic flying. I assume there is a plane involved, but in California one can never be too sure. . . . **Mike Gerardi** wrote a letter describing his work in the Analysis Group of the Propulsion and Power Department of Rockwell International in Los Angeles. During space shuttle missions, Mike serves on the fuel cell flight support team. Predictably, Mike writes that he's "enjoying the southern California life and doing fine." . . . **Steven Keith**, who currently works as an analyst on the MX guidance system, found out in Los Angeles that he has "the same hands as Humphrey Bogart." California—truly a profound place to visit.

On the other sunny side of the country, **Michelle Lucier** is working in the RF Design and Analysis Section at Harris Government Systems in Melbourne, Fla. Michelle is attending F.I.T. part-time, working for her master's in electrical engineering. In her spare time, Michelle enjoys sailing, camping, skiing, community soccer, and softball. . . . **Dave Nelson** is attending the University of Texas in the graduate aeronautics school. In his spare time he is playing in a new wave band, "Kamikaze Refrigerators."

Winner of this month's You-won't-believe-what-I-did-in-just-a-year Award is classmate **Marc Chelemer**. Here is a brief synopsis of the novella that Marc managed to fit on his reply card. Having settled in Buffalo, Marc is pursuing research in the Energy Systems Section of the Linde Industrial Gases Division of Union Carbide Corp. In community affairs, Marc is an active member of the Albright-Knox Art Gallery, the Lexington Real Foods Community Co-op, and serves as program committee chairman of the Buffalo Ornithological Society. Additionally, Marc is active in local theater; he is managing an upcoming production of *Damn Yankees*, has finished a directing workshop, and is forming the Linde Players at Union Carbide. Aside from all this, Marc writes that he has been skiing, attending the symphony, and is starting a business venture of his own. I might add that, in his spare time, Marc breathes and occasionally eats.

Jeremy Barkan has been doing research in chemistry at Hebrew University in Jerusalem and is planning to start doctoral work at the Weitzmann Institute next year. . . . Finally, **Daniel Packer** is working for Killingsworth, Liddy and Co., a management consulting firm for the sports and entertainment industries. He is engaged to Bonnie Feinroth and planning to be married in June 1983. Congratulations! . . . Keep those cards and letters comin'.—**Chuck Markham**, Secretary, 532 Beacon St., Boston, MA 02215

82

Hope you had a great summer! Many people wrote to tell me what they're doing. Some of you won't be listed until next issue. Don't worry—I haven't forgotten you!

Ken Felsher is attending New York Law School. . . . **Thai Duc Trinh** is at Johns Hopkins Medical School. . . . **David Shapiro** is a research assistant at ICF—a consulting firm in Washington, D.C. . . . **Robert Powell** will be "hacking for Microsoft" in Seattle. . . . **Tibor Lukes** will be attending Berkeley for a master's. . . . **Kriss Replogle** has had enough of the 'Tute and will be going to grad school. . . . **Laurie Blake** will be at lovely Troy, N.Y., for grad school at R.P.I. . . . **Martin Huber** is heading to Stanford for grad school. . . . **David Wilson** will be in military service. . . . **Lisa Greenfield** will be at Sloan. . . . **Kirk Holmes** is at Sonicraft in Chicago. . . . **Dale Gordon** will be at M.I.T. for grad school. . . . **Allison Casey** is at Motorola Semiconductor in Phoenix, Ariz. . . . **Thomas R. James** is at Valley Forge, Pa., in General Electric's Space Division. . . . **Regina Houston** will be at Berkeley grad school and also plans to get married.

Congratulations to **Eva Wu** who won an AMITA award recognizing academic excellence. . . . **Mike Colucci** will be attending the University of Texas at Austin for grad school. . . . **Emmy Behlau** will be at Dartmouth Medical School. . . . **Bob Wallace** will be going abroad to work for Royal Dutch Shell in England. . . . **Eric Aslakson** will be going to Caltech to work for a physics Ph.D. . . . **Bill Nunan** is co-oping with RCA through the fall and will return to M.I.T. in the spring for grad school. . . . **Richard Auchus** is in the Washington University M.D.-Ph.D. program; **Pat Tong** is also in the program. . . . **David Hoffman** will be at the University of Pennsylvania Law School. . . . **Mark Szarawarski** is working at Westinghouse.

Someone wrote to tell me that they will be attending Harvard Business School, but they didn't tell me who they were. . . . **Catherine Briasco** is at grad school at Stanford in chemical engineering. . . . **Aaron Rapoport** is going to Harvard Medical School. . . . I'm alive and well and living and working in Cambridge. Please keep me and the class up to date on what you're doing. And if you know what any other '82ers are doing, let us know.—**Rhonda Peck**, Secretary, 282 Massachusetts Ave., Cambridge, MA 02139

30-minute "concert" before the Sunday morning prayer service. I joined them one weekend.

Follow a Mental Map

To gain entrance to the chamber where these efforts take place, we first sought a switch next to an unobtrusive door on the left side of the foyer that lights a bulb in the tower. Then we climbed almost straight up to the ringing room.

The cold room is lit by bare yellow bulbs; the aged floor is of wide pine planks. Miniature benches sit near the walls. Round windows cut through the thick brick walls, their panes like spokes of a wheel.

On this Sunday morning in spring, eight ringers stand in a circle and pull ropes that disappear through holes in the ceiling. The ropes are attached to the ancient bells above them. The bells predate the Liberty Bell and are the only unmodified set of their maker, Abel Rudhall, remaining in existence. The ringers must stretch high to grasp the ropes on a thick tufted part (called the sally) and pull hard to "raise" the bells. Once raised they are ready for change ringing.

"How does the change ringer know when to ring?" I ask.

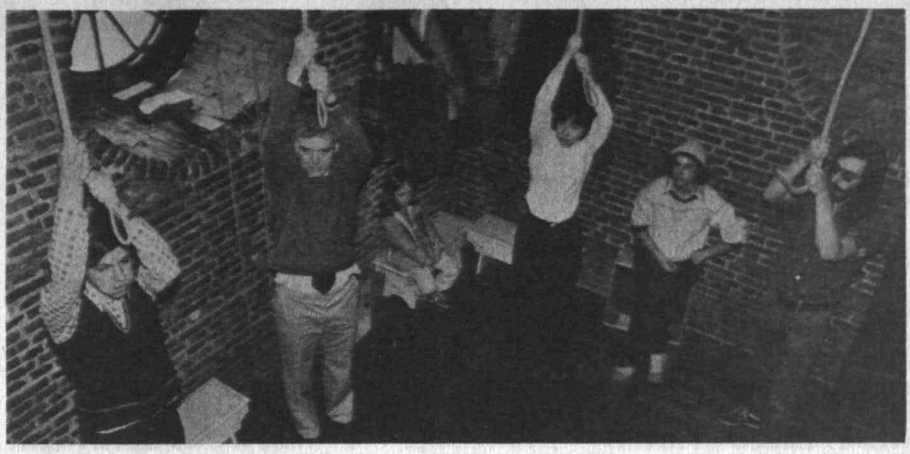
"Each ringer follows a mental map that represents the pathway of his or her progress through the changes," Dr. Davies explains. An example is the following sequences (called plain hunting) in which the rows look like:

```
12345678
21426587
24163857
42618375
46281735
64827153
68472513
86745231
87654321
78563412
75836142
57381624
53718264
35172846
31527486
13254768
12345678
```

Number one bell rings first in the first sequence, then second in the second sequence, and so on. The ringer need know only how many rings strike before his or hers with no attention to the others' places. The sequences can be arranged in enormous complexity, limited only by two rules: a bell may not strike in the same position in more than two rows consecutive and it may not move more than one position either way in going from one row to the next.

When the Ringing Master says "This is all," the starting row has been reached and from that point on the ringers will ring in this diatonic sequence (12345678) until the command is heard to "stand"; then the bells come to a stop, one by one, in the fixed upright position.

If a "falseness" appears (when two rows are identical), the conductor must correct it or immediately say "stand" to stop the ringing. The complexity of possible combinations keeps people engaged with computers.



Sounding Through the City

Today, first the change ringers labor to move the bells into the "up" position, with their wide mouths facing upwards. (The biggest bell, the "tenor," weighs nearly 1,600 pounds and strikes F). The bells have a silencer on the clapper now, to be removed when the change ringing begins. Banter and chatting are exchanged, above the sound made by the ropes sliding through the holes in the ceiling which calls to mind the hum of a clothes dryer. Suddenly "Keep your mind on it!" is sharply interjected into the banter by Ringing Master Alex Storrs, '82. Now the students labor in sequence, stretching up and bending down; there is a wave of movement progressing around the circle.

Turn from these eight workers and walk up another set of thin convoluted stairs and you come out on a level with the bells, about 25 feet above the ringing room ceiling. It is hard to imagine that they are nearly 240 years old. (Paul Revere was a member of the first band to ring them.)

The old wooden frame is soaked with oil from the worn-out plain metal bearings; the bells hang at a slight angle because it has been warped by long exposure to the elements. Each bell has a cast-in inscription recording its birthdate, 1744. The Church has launched a $100,000 appeal to refit this unique instrument with a modern frame lower in the tower so that they can be rung for many years more without risk of irreparable loss. The campaign is doubly urgent because the Whitechapel Bell Foundry, of London, England (the only remaining foundry capable of making the necessary bell frame and fittings) is worried about its survival in the face of recession.

"Don't lean over the bells!" warns Laura Dickerson, a member of the guild. They would kill you easily, slamming their weight to the other side when they ring. The sound up there is so loud it's painful. Yet outside it carries only a few blocks before it's muffled by city buildings.

"Three If By Nuclear War . . ."

The ringing ends too soon for me, but now the service in the church is about to begin. Change ringers gather their belongings and begin to wind their way back down the stairs . . . Few people in the country have this chance, I think, to experience an art so linked with history. But my romantic reveries are interrupted:

"We've all made elaborate plans to be here if there is a nuclear holocaust," one of the change ringers says, "to ring till we glow."—*M.L.*

Opposite page, counter clockwise from top left: Arthur Lewbel, graduate student, level with the bells, about 25 feet above the ringing room ceiling; the bells move in a circular path; hands grasp the "sally", a thick tufted part of the rope used to ring the bells. This page: change ringers work in sequence. Photos: James J. Snyder, '80

For the past 17 years—one-third of Professor Harold E. Edgerton's tenure at M.I.T.—a "workhorse" strobe light which he installed there has flashed 40 times a minute from the top of the Prudential Tower, second-tallest building in Boston. Its task of proving that strobes could be effective in lighthouses along the New England coast is finished now, so "Doc" Edgerton (right) and his assistant Vernon E. MacRoberts have retrieved and reconditioned the strobe. Now it's flashing from the roof of M.I.T.'s Building 4, just above "Doc's" famous "stobe alley" exhibit.

Closing Our Door to Foreign Students and Teachers?

Two little-noticed proposals for changes in U.S. immigration and alien control regulations in an Immigration Reform and Control Act now before Congress (H.R. 5872 and S.2222) have attracted oppostion and dismay at M.I.T.:

☐ The new law would deny immigrant visas to "professionals" per se, forcing them to qualify as persons of "exceptional ability" if they wish to work in the U.S.

☐ The new law would require foreign students to return home after graduation for at least two years before applying to settle and work in the U.S. more permanently.

This "home-country residence requirement" for newly-graduated students, says Professor Francis E. Low, provost of M.I.T., would deprive both industry and educational institutions of "a source of highly educated and badly needed professionals." In a letter to Senator Strom Thurmond, chairman of the Senate Judiciary Committee, Professor Low characterizes the proposed requirement as "punitive."

Eliminating professionals as candidates for immigrant visas would endanger some aspects of U.S. technical and scientific leadership, Professor Low wrote to Senator Thurmond. "In order to stay at the forefront of scientific and other scholarly developments," Professor Low wrote, "our nation's universities must be able to attract the most able staff possible, regardless of nationality."

The proposed law threatens to curtail the "free exchange of ideas which has made this country a world leader in education. If the U.S. is to maintain preeminence in science and technology we must be able to focus our attention on an individual's talent rather than citizenship," Professor Low said.

Deceased

Allston T. Cushing, '11; May 7, 1982; 16237 Gledhill St., Supulveda, Calif.
D.P. Gaillard, '11; March 26, 1982; 1940 Shepard St. NW, Washington, D.C.
Kenneth C. Robinson, '12; April 26, 1982; 5330 SW Orchid St., Portland, Ore.
Dewitt C. Ramsay, '15; November 21, 1981; Lake House Apt. 805, 11850 Edgewater Dr., Lakewood, Ohio.
Walter C. Wood, '17; April 16, 1982; 3639 Charles St., San Diego, Calif.
Robert T. Collier, '18; December 18, 1981; PO Box 158, Escalon, Calif.
Karl L. Ford, '18; July 7, 1981; 2112 Hollywood Ave., Muncie, Ind.
Walter R. Herfurth, '18; November 28, 198l; 8 Paseo Redondo, Tucson, Ariz.
Harold L. Smith, '18; March 25, 1982; 1124 Palma Sola Blvd., Bradenton, Fla.
Max Knobel, '19; May 7, 1982; 453 Beacon St., Boston, Mass.
John Stevens, '19; May 6, 1982; 339 Lake Rd., Menasha, Wis.
Henry H. Blau, '20; February 11, 1980; 48 Highland Circle, Wayland, Mass.
Robert B. Pollock, '20; April 28 , 1981; 1940 Jefferson Dr., Pasadena, Calif.
Ivan F. Chambers, '21; October 31, 1981; 237 Colville Rd., Charlotte, N.C.
Samuel T. Drew, '21; April 26, 1982; 579 Hunting Lodge Dr., Miami Springs, Fla.
Aaron A. Tushin, '21; February 24, 1982; 1300 Highfield Dr., Clearwater, Fla.
Eleanor Spillsbury, '22; April 9, 1982; 470 Washington St., Woburn, Mass.
Karl A. Swett, '22; January 9, 1982; 12A Cambridge Circle, Leisure Village West, Lakehurst, N.J.
Powell Robinson, '23; November 28, 1981; PO Box 542, New Vernon, N.J.
Harry C. Bailey, '24; January 20, 1982; 835 Edson Dr., Beaumont, Tex.
John E. Jackson, '24; October 21, 1981; 5345 Inglewood Rd., c/o G. Jackson, Lynchberg, Va.
Sidney E. Miller, '26; January 20, 1981; 421 Rawson Woods Lane, Cincinnati, Ohio.
Charles L. MacLauchlin, '27; March 15, 1982; Old Colony Village, Hancock 111-15, Orleans, Mass.
Bolick J. Shadrake, '27; February 9, 1982; 5219 Berkshire Dr., North Olmstead, Ohio.
David E. Truax, '27; May 7, 1982; 1300 Reece Rd., Apt. 301, Charlotte, N.C.
Otto H.O. Brune, '28; April 27, 1982; 1307 Arcadia St., Pretoria, So. Africa.
Elston W. Meyer, '28; April 28, 1982; 1 Eton Dr., Caldwell, N.J.
Theodore Packard, '28; February 25, 1982; 4420 Village Oaks Trail, Atlanta, Ga.
Charles W. Denny, Jr., '29; January 7, 1981; 268 Mooring Line Dr., Naples, Fla.
Mrs. Richard R. Wolfe, '29; May 20, 1980; c/o Mrs. John T. Hubbell, Clarksville Rd., Francestown, N.H.
William P. MacKusick, '30; March 18, 1982; c/o Robert MacKusick, 2895 Edgehill, Cleveland, Ohio.
Meir H. Degani, '32; April 23, 1982; 549 W. 123rd St., New York, N.Y.
Thomas F. Duggan, '32; July 1975; 6 Westway, Lynnfield, Mass.
Raymond J.B. Hoffman, '33; September 8, 1979; 1364 92nd Ave. NE, Bellevue, Wash.
William L. Walsh, '33; June 3, 1981; 574 B Fairway Circle, Ocala, Fla.
Ronald A. White, '33; October 29, 1981; 9550 Oak Pass Rd., Beverely Hills, Calif.
Charles E. Sheehan, '34; March 31, 1982; 108 Chestnut St., Stoughton, Mass.
Carbon C. Dubbs, '35; April 7, 1982; Melbourne House, 227 Australian Ave. #2E, Palm Beach, Fla.
Joseph A. Simendinger, Jr., '35; 1981; 160 Sun Ridge Lane, Stratford, Conn.
Samuel P. Felix, Jr., '39; July 30, 1981; PO Box 89, Carmel, Calif.
Robert N. Bonnett, '40; February 22, 1982; 481 Yorkshire Dr., Severna Park, Md.
John R.V. Dickson, '40; April 23, 1982; 1 Gladden Rd., Annapolis, Md.
Arthur J. Dore, '41; February 22, 1982; 10216 Regal Dr. Apt. 309, Largo, Fla.
William J. Dimitrijevic, '42; September 23, 1981; 5727 Blaine Rd., Churchtown, Md.
William F. Cassidy, '43; October 21, 1981; 9499 119 Way N, Seminole, Fla.
Peter V. Schwab, '45; September 29, 1972.
John B. Garrison, '47; November 11, 1981; 13408 Clifton Dr., Silver Spring, Md.
George C. Grogan, Jr., '48; December 1981; 633 Trueno Ave., Camarillo, Calif.
Lawrence A. Harris, '48; May 7, 1982; 2259 Berkley Ave., Schenectady, N.Y.
Roger B. Woodbury, '48; May 5, 1982; 68 Pine St., Weston, Mass.
Charles A. Domenicali, '49; March 23, 1982; 1933 Pine St., Philadelphia, Penn.
Cary J. King, Jr., '49; February 3, 1982; 1034 St. Joseph Ave., Los Altos, Calif.
Benjamin W. Roberts, Jr., '49; June 15, 1981; 1921 Regent St., Schenectady, N.Y.
Leon M. Polinski, '52; February 15, 1982; 2412 Broadlawn Dr., Upper St. Clair, Penn.
Edward M. Rex, '54; April 3, 1980; 9415 Encino Ave., Northridge, Calif.
Aldo DeSimone, '56; April 20, 1982, McLean, Va.
Bertram Berger, '57; April 3, 1982; 126 Billings St., Sharon, Mass.
Margie Kaminsky, '68; January 29, 1981; 25 Holly St., Denver, Col.

Courses

Takeo Iguchi, consul-general of Japan in Boston, prepares to present Professor Jacob P. Den Hartog of the Department of Mechanical Engineering with the Third Class of the Order of the Rising Sun—a national honor which recognizes Professor Den Hartog's contributions to Japanese engineering through many former students and through his personal efforts to improve U.S.-Japan understanding. With them are (left) Osamu Niwa, vice-consul, and (right) Howard W. Johnson, chairman of the M.I.T. Corporation.

I
Civil Engineering

John Hughes, S.M.'74, has been named senior vice-president of the Carlson Corp., Inc., Cochituate Mass., an international architectural, engineering and construction services firm. His responsibilities include manager of projects, construction, and purchasing for the Northeast, mid-Atlantic, and mid-Western regions. . . . **Cordell W. Hull,** S.M.'57, chief financial officer of Bechtel Group, Inc., has been elected to the additional posts of director of the three principal operating companies—Bechtel Power Corp., Bechtel Petroleum, Inc., and Bechtel Civil and Minerals, Inc.

Irwin J. Kugelman, Sc.D.'60, has assumed responsibilities as director of the Center for Marine and Environmental Studies at Lehigh University, Bethlehem, Penn., and has also been named professor of civil engineering. Dr. Kugelman was previously chief of pilot plant and field evaulation for EPA's Wastewater Research Division, having joined EPA's Advanced Waste Treatment Laboratory in 1970. . . . **Antonio A.G. Sa da Costa,** Ph.D.'80, reports that he is currently assistant professor of hydraulics at the Technical University of Lisbon. As he left M.I.T. two years ago he was the recipient of the Lorenz G. Straub Award for 1980, for the doctoral thesis judged to be the most meritorious in water resources. . . . **George T. Turci,** S.M.'56, has resigned as a director of the American Bakeries Co., Chicago, Ill. . . . **Avinash C. Singhal,** Sc.D.'61, writes that he was awarded $148,390 research grant by the NSF to set up testing facilities for pipeline joint tests at Arizona State University, Tempe. He also received the Henry Adams Research Award from the Institute of Structural Engineers in London for his paper on earthquake effects.

Antoine E. Naaman, Ph.D.'72, reports that he has been appointed full professor in structural design in the Department of Materials Engineering, University of Illinois at Chicago Circle; he has just completed a book, *Prestressed Concrete Analysis and Design* (McGraw Hill). . . . **Alexis Ostapenko,** Sc.D.'57, professor of civil engineering at Lehigh University, has been honored for his 25 years of service on the faculty. He joined the Lehigh faculty as assistant professor and was named professor of civil engineering in 1965 and serves as director of the Structural Stability Division of Fritz Laboratory. . . . **George Bugliarello,** Sc.D.'59, president of the Polytechnic Institute of New York, has been named the Marconi Council Secretary for the Marconi International Fellowship administered by the Aspen Institute for Humanistic Studies, Colo.

II
Mechanical Engineering

Professor **Jacob P. Den Hartog** has been honored by Japan with the Third Class of the Order of the Rising Sun, recognizing his efforts to promote friendship and understanding between the two countries and his contributions to raising the level of engineering in Japan.

To his many honors for teaching and research, Professor **James H. Williams, Jr.,** '67, may soon add a very different citation: one of the "men of Boston" in *Playboy's 1982 Fall Fashion Guide.* The *Boston Globe,* reporting the possible selection, noted that Professor Williams owns six cars and some 50 suits, but Professor Williams was unmoved: "My friends already know I have a tremendous ego so they won't be surprised," he quipped.

Gregory C. Tocci, S.M.'73, president of Cavanaugh Tocci Associates, Inc., Natick, Mass., has been elected a director of the National Council of Acoustical Consultants for a two-year term which was effective July 1, 1982. The NCAC is "an international organization of acoustical consulting firms representing hundreds of practicing independent consultants throughout the world." . . . **George M. Hyman,** S.M.'75, writes, "I am now manager of MD Applications Software for Computervision . . . I was married to Rosemary Phalen on May 23, 1982." . . . **Stephen R. Femino,** S.M.'64, received his M.B.A. degree from the University of Washington in the Spring of 1982 and is currently a senior engineer at Boeing Aerospace Co.

Neal P. Jeffries, S.M.'58, currently director for the Center for Manufacturing Technology, Cincinnati, Ohio, has been re-elected for a two-year term (extending through April 1984) as a member of the board of directors of the Society of Manufacturing Engineers.

III
Materials Science and Engineering

Mrs. Olof G. Sundin, '47, writes, "Am working on portrait commissions in porcelain. My husband 'commutes' to Sweden where the family factory is. Our oldest son Olaf received his Ph.D. degree in biology (M.I.T. '81) and is now a post-doctoral fellow at Cold Spring Harbor, N.Y.; and our son Eric is at the Tuck School of Business (Dartmouth) studying for his M.B.A." . . . **David T. Novick,** S.M.'59, writes, "After seven years as technical director and one year as manager of new business planning for the Hanovia Liquid Gold/Thick Film Materials Department of Engelhard Industries (Engelhard Corp.), I have received appointment to a divisional staff position as manager of diversification planning in Engelhard's New Ventures and Diversification Department."

Donald J. Blickwede, Sc.D.'48, retires from the post of vice-president and director of research for the Bethlehem Steel Corp., Bethlehem, Penn., on July 31, 1982. He joined the firm in 1950 as a research engineer and was elected vice-president in 1964. Earlier he had been head of the High-Temperature Alloys Branch of the Naval Research Laboratories and a metallurgist at Curtiss-Wright Corp.

G. A. Hack

J. R. Myer

New Heads in Architecture and Planning

The School of Architecture and Planning will begin the fall with new heads at the helms of both its departments.

Professor Gary A. Hack, Ph.D.'76, will be new head of the Department of Urban Studies and Planning, succeeding Professor Lawrence E. Susskind, Ph.D.'73. And Professor Julian Beinart, M.Arch.'56, who has served as interim head of the Department of Architecture since 1981, will be succeeded by Professor John R. Myer, '52, who becomes head of the department.

Dean John P. deMonchaux of the school credits Professor Hack with "bringing practice into his teaching and research, and improving practice through research and teaching. He has brought new direction and energy into the area of environmental design research," said Dean deMonchaux. Professor Hack first came to M.I.T. in 1971 and almost at once became director of the Environmental Design Program in the department. His training was at the University of Manitoba (B.Arch 1964) and the University of Illinois (M.Arch 1966, M.Plng. 1977).

Professor Myer founded Arrowstreet, Inc., a distinguished Cambridge architectural firm, two years after he returned to M.I.T. to join the faculty in 1959; he is now director and president of the firm, whose work "bridges the fields of architecture and planning," said Dean deMoncheaux. And Professor Myer's interests and experience are especially appropriate, the dean said, "at a time when there is increasing interest in the relationship of education to practice."

Both Professors Susskind and Beinart will continue as members of the faculty, giving full time to teaching and research.

IV
Architecture

Gene H. Clements, M.Arch.'68, reports, "I have had my own architectural practice for five years and have just moved into a new office in Berkeley, Calif." . . . **Paul Peng-Cheng Sun,** M.Arch.'66, writes, "I am a new partner in the firm of Shepley, Bulfinch, Richardson, and Abbott, architects, Boston, Mass. Also, I am leading an earthwatch expedition to the northwest of China during this summer." . . . **Hans-Christian Lischewski,** M.Arch.'79, writes, "I recently founded together with Martha Leinroth and **Daniel Franzblau,** '79, a firm called Most Media, Somerville, Mass., to specialize in the application of high-tech design aids for architects and engineers. The company offers service in architectural exterior and interior photography with emphasis on model photography using wide-angle lenses and modelscopes. Consultation in the use of other media such as holography, video disc technology, and raster scan computergraphics is also available. Computer-aided building design (CABD) services and computer graphics production will be offered later this year."

Josephine O. Adams, M.Arch.'80, reports she is currently a project design manager at Sigmacon, Orlando, Fla., heading the design department. "We do all work for General Mills, Red Lobster, Good Earth, and other restaurants throughout the nation." . . . **William Hubbard,** M.Arch.'76, has recently written a book *Complexity and Conviction: Steps Toward an Architecture of Convention* (M.I.T. Press). Paul Goldberger in the *New York Times Book Review* says the book "might be called the first serious critique of post modern architecture." The author, says Richard Pommer in *Art Journal*, "wants to find the grounds for broad agreement about new architecture to insure its enduring respectability, equally safe from the illusory objectivity of early modern architecture and the perverse contradictions of the Venturis."

V
Chemistry

William D. Phillips, Ph.D.'51, professor of chemistry and chairman of the Department of Chemistry at Washington University, St. Louis, Mo., has been elected a director of the Sigma Aldrich Corp., St. Louis, a maker of biochemicals and organic and inorganic chemicals. . . . **Paul F. Troiano,** Ph.D.'64, a division manager Cabot Corp., Boston, Mass., has been given the additional title of vice-president of this producer of chemicals, alloys, oil, and natural gas.

VI
Electrical Engineering and Computer Science

Hermann A. Haus, Sc.D.'54, Elihu Thomas Professor of Electrical Engineering, holds the $5,000 James R. Killian, Jr., Faculty Achievement Award for 1982-83, a recognition by his M.I.T. faculty colleagues of extraordinary professional accomplishments. As a graduate student he made important contributions to the theory of noise in electron circuits, and since then he has gained recognition for outstanding teaching in electromagnetism and quantum electronics as well as continued research on high-frequency noise in all kinds of electron devices. He has also worked on other issues relating to the electrodynamics of moving media, including the pulsing of lasers and semiconductor systems and ultra-high-speed switching in optical waveguides. "The hallmark of Dr. Haus' analytical work," wrote the faculty nominating committee, "is that it . . . regularly generates new insights and analytic tools with considerably wider application than the immediate . . ."

Albert E. Cookson, S.M.'51, formerly senior vice-president and general technical director of International Telephone and Telegraph Corp., New York City, has been promoted to the position of chief scientist. He first joined ITT at its Nutley, N.J., research center in 1951. . . . **John A. Mathews,** '30, writes, "I have developed a method of setting income tax rates such that they would generate a pre-determined amount of revenue while maintaining a pre-established pattern of rate progression. Indexing such rates would thus be obviated. By expressing the distribution of income with the Pareto Law in the upper ranges of income, and with a modification of that law in the lower ranges, and then defining the rate structure in similar terms, a parameter of the rate formula can be adjusted to cause the product of the formulas to generate a desired amount of revenue without substantially altering the progressivity of the rates. A bill proposing adopting this method was recently introduced in the Maryland House of Delegates but was rejected by its Ways and Means Committee. The Minnesota Commissioner of Revenue is now considering application of the method to that state."

Nolan T. Jones, S.M.'74, reports, "We were in Athens, Greece, from July 1970 to October 1980 for Mitre Corp., working on command and control systems for all branches of the Greek military. Since August 1981, I have been working on the automation of airborne command-post aircraft. . . . Wife, Beverly, succumbed to cancer in July 1981." . . . **Robert J. Shillman,** Ph.D.'74, was recently appointed president of Cognex Corp., Boston, Mass., a manufacturer of industrial vision systems aimed at the robotics and automated factory marketplaces. Among founders of the firm was **Robert Piankian,** S.M.'72, who recently resigned his position as director of computer engineering at the Laboratory of Computer Science at Massachusetts General Hospital. He reports that "the first order for our product, DataMan, came from IBM. In the past year, my wife Esther Horwich opened her own law practice. I still find the time to run 30 miles a week along the banks of the Charles River." . . . **Wilbur L. Pritchard,** '52, reports that he is president of the Direct Broadcast Satellite Corp.

Edwin L. Gabriel, '51, reports that he recently (February 9, 1982) received a patent entitled "Educational Analog Computer Laboratory." It covers "a $100 book-sized computer with many unique features, including some enabling it to be less dependent on an oscilloscope. Permanent circuits are either exposed or indicated by solid lines. Circuits are modifiable, enabling this computer to have the capacity of one having twice the number of computing components that are not modifiable." . . . **Gerald G. Probst,** S.M.'56, chief executive officer of the Sperry Corp., New York City, has been elected to the additional post of chairman of the firm. He has been with Sperry since 1961 in a number of key executive posts, including president of Sperry Univac from 1971 to 1978. . . . **James L. DuBard,** S.M.'62, has been appointed head of the Basic Studies Section in the Control Devices Division at Southern Research Institute, Birmingham, Ala. Projects of the section, part of the Environmental Sciences Research Department, include a mathematical model of the electrostatic precipitaton process and a study of the process of electrically charging particles within precipitators.

VI-A Program

By the time this article appears in *Technology Review*, 243 students will be completing their 1982 company summer assignments at locations throughout the United States. A record 40 of these are assigned to the San Francisco Bay area: 13 at Fairchild; 18 at Hewlett-Packard; 3 at I.B.M., and 6 at Xerox's Palo Alto Research Center. Also completing their assignments will be the first two students to go with Analog Devices, Inc.'s Semiconductor Division, Wilmington, Del.

The second departmental workshop on life-long cooperative education in preparation for the department's centennial celebration on October 2, 1982, was held on June 7 and 8 with some 36 rep-

resentatives from industry and academia attending. Several unique plans will be presented, at that time, to support the continuing education of engineers in industry. Director Tucker attended and happily reports that the VI-A program was constantly referred to as an excellent example of the type of desirable cooperation between universities and industry.

Paul E. Stoft, '49, director of technical strategy analysis at Hewlett-Packard Co. and overall VI-A coordinator for H-P, has written a paper entitled "A Case Study of Hewlett-Packard's Interaction With Two Master's-Degree Educational Programs." Again, the VI-A program emerges as a highly successful co-operative enterprise with a leading company in the electronics field.

Taking over as VI-A faculty advisor to I.B.M.'s Watson Research Laboratory, Yorktown Heights, N.Y., is **Richard E. Zippel,** '79. He replaces Professor Dimitri A. Antoniadis, who is deeply involved in the department's VLSI program.

Technology Day, June 11, found several VI-A grads on campus who talked with Director Tucker: **Philip E. Fox,** '42, retired from IBM Labs, who came as an interviewer back when IBM first recruited VI-A students; **Martin P. Lurie,** '78, who is on educational leave from IBM's General Technology Division, Burlington, Vt., to study in the M.B.A. program at Boston University; **H. DuBose Montgomery,** '71, of Menlo Park, Calif.; and **James B. Smith,** '32, of Wellesley Farms, Mass., here for his 50th class reunion, who made it a special point to also visit Professor (Emeritus) **Karl L. Wildes,** '22, at his 100 Memorial Drive apartment.

A recent visitor to John Tucker's home in Wellesley, Mass., was **Allen K. Wells,** '80, who is employed with Charles River Data Systems, Natick, Mass. Visitors to the VI-A office since our last article included: **Eric D. Black,** '77, from Palo Alto, Calif.; **Philip B. Giangarra,** '76, with the Codex Corp., Mansfield, Mass.; and **David E. Meharry,** '70, with Sanders Associates, Nashua, N.H.—John A. Tucker, Director, Course VI-A, Room 38-479, Cambridge, MA 02139.

VII
Biology

A **Charles Edward Holt** Memorial Lectureship has been established to perpetuate "the spirit of the commitment to education" of the late Professor Holt. As a tribute to Professor Holt's "leadership, imagination, and dedication to undergraduate education," the department plans to invite a distinguished scientist and teacher to present a major public lecture directed toward the entire M.I.T. undergraduate community each year. The hope is that the lecturer will be on the campus long enough to contribute to many aspects of undergraduate education, thus adding a "novel and significant dimension" to the lectureship. Undergraduates will have a major role in selecting the lecturer and in organizing the visit. Professor Holt died suddenly of a heart attack while visiting in Germany in February; contributions to the lectureship fund can be sent to the Alumni Fund or directly to Maija Ahlquist in the Biology Department.

Edward P. Hutchinson, Ph.D.'33, professor of sociology emeritus at the University of Pennsylvania, was presented an honorary degree at the 177th Commencement exercises of Bowdoin College, Brunswick, Me. Professor Hutchinson, who is an internationally recognized authority on the use of statistical methods as they apply to immigration and population, received the Doctor of Humane Letters, for which he was described as "demographer, historian, teacher, scholar, and generous and loyal alumnus."

VIII
Physics

Simon Foner, chief scientist who is head of the Research Division of the Francis Bitter National Magnet Laboratory, has been elected councillor of the Executive Committee of the Division of Condensed Matter Physics, American Physical Society, for a four-year term. He was chairman of the division in 1980.

Michael Marx, Ph.D.'74, reports that he is currently a professor of physics at the State University of New York, Stony Brook. . . . **Allen J. Cohen,** Ph.D.'70, writes, "I graduated from medical school in 1977 and finished a radiology residency in 1981. I am presently assistant professor of radiology at the University of California, Irvine, in charge of the emergency room radiology section, and I also practice nuclear medicine at the university."

Carl S. Schneider, Ph.D.'69, is currently a professor of physics at the U.S. Naval Academy and is looking forward to an assignment in 1982-83 in Weymouth, England, as visiting research fellow with the British Defence Ministry.

M. C. Potter

IX
Psychology

Dr. **Walle J. H. Nauta,** Institute Professor, is the recipient of two major international honors: an honorary M.D. degree from the Universidad Autonoma of Madrid; and honorary membership in the International Brain Research Organization, conferred during its first International Congress on the Brain in Health and Disease in Lausanne, Switzerland.

Mary C. Potter, who joined the department in 1975 as associate professor, has been promoted to the rank of full professor. Dr. Potter holds degrees in psychology from Swarthmore and Radcliffe (Ph.D. 1961). She was research fellow at Harvard for nine years, then joined the M.I.T. Department of Urban Studies and Planning as associate professor in 1970.

X
Chemical Engineering

Robert A. Casper, S.M.'74, has been appointed head of the Biomaterials Section at Southern Research Institute, Birmingham, Ala., where his group conducts research on biomedical devices, biomedical engineering, dental materials, aids for the handicapped, and specialty polymers. Prior to this position his work over the past two years as a biomedical engineer has been concentrated on development and testing of synthetic materials for use within the body. . . .**Guy Thornton McBridge, Jr.,** Sc.D.'48, president of Colorado School of Mines, has been elected a director of Kerr-McGee Corp., Oklahoma City, Okla., an energy, chemical, and natural resources concern. . . . **Maurice F. Granville,** S.M.'39, retired chairman and chief executive officer of Texaco, Inc., was elected a director of First Florida Banks, Inc., Tampa, a holding company.

Jerry McAfee, Sc.D.'40, retired chairman and chief executive officer of the Gulf Oil Corp., has been elected a director of the McDonnell Douglas Corp., St. Louis, Mo. . . . **Roy J. Handwerk,** S.M.'54, is presently director of marketing for the Dexter Corp., Chagrin Falls, Ohio. . . . **Arnold F. Stancell,** Sc.D.'62, writes, "I have moved from vice-president and general manager of Mobil's plastics business to a two-year assignment as

manager of all Mobil's corporate planning, and now off to London as regional executive of Mobil's European marketing and refining businesses."

Irwin Gruverman, S.M.'55, writes, "Have founded Biotechnology Development Affiliates early in 1982. BDA manages transfer of university research to industry through support of projects with commercial potential, venture capital application, and industrial consulting assignments." . . . **David Hackor,** S.M.'50, reports, "I have left academia at the University of Illinois (officially retired) for greener pastures. Now at Amoco Research Center, Naperville, Ill., as a senior research engineer in chemical intermediates. I have been developing new separation techniques for purification of some of the main product lines."

XI

Urban Studies and Planning

H. James Brown, professor of city and regional planning in Harvard's John F. Kennedy School of Government, is the new director of the Harvard-M.I.T. Joint Center for Urban Studies; he succeeds Professor David T. Kresge, who resigned during the spring to become vice-president for economics of the Union Pacific Corp. Professor Brown, who is chairman of the city and regional planning program at the Kennedy School, is a specialist in housing economics and land use.

Steven Lewis Yaffee, Ph.D.'79, assistant professor of planning at Harvard, is the author of *Prohibitive Policy: Implementing the Federal Endangered Species Act* (Cambridge: M.I.T. Press, 1982, $17.50). The book's goal is described as two-fold: to examine "prohibitive policy" as an extreme form of government regulation that has been used increasingly in recent years, especially in the environmental area; and to report on the record of the federal government, under the Endangered Species Act, in preserving threatened wildlife. Dr. Yaffee's conclusion: the process of implementation provides for balancing and negotiation even though they appear to be outlawed by statute in the case of "prohibitive" legislation.

David S. Stern, Ph.D.'72, writes, "I have just published *Managing Human Resources: The Art of Full Employment* (Auburn House Publishers). It describes practices by employers and governments that can make full employment more sustainable." . . . **James E. Wallace,** Ph.D.'72, reports that in 1981 while at Abt Associates, Inc., he completed a federally-sponsored national study of the new construction and existing housing (rental subsidy) program of the Department of Housing and Urban Development; then for nine months he was in charge of the housing programs of the President's Commission on Housing, in Washington.

Alan Sager, Ph.D.'79, writes, "Just completed studies on the closure of hospitals that serve the poor and on living at home: the role of informal supports and public services in sustaining older Americans. Still teaching at the Heller Graduate School at Brandeis University." . . . **Frederick W. Todd,** M.C.P.'68, is a principal in the firm of Hammer, Kieter, and Todd, Inc., architects and planners, Cambridge, Mass. . . . **Robin C. Moore,** M.C.P.'67, reports, "After five years of freelance consulting, I recently joined the faculty of the School of Design, Landscape Architecture Program, at North Carolina State University, Raleigh. I was also elected to the board of the Environmental Design Research Association this year."

Lydia Kowalski, M.C.P.'73, director of Boston's Museum of Transportation, was elected to the Board of Trustees of the Massachusetts Cultural Alliance at its 13th annual meeting. The Alliance is a non-profit organization, established in 1969, which serves the cultural community of Massachusetts as a forum for communication, a focus for collaboration, and a support structure for resource development. . . . **Con Howe,** M.C.P.'75, has been appointed director of the Manhattan Office of the Department of City Planning, New York City Planning Commission. He has been the department's assistant executive director for community development and capital programming since July 1980 and was responsible for recommending allocation of community development and city capital budget funds.

XII

Earth and Planetary Sciences

Keiiti Aki, professor of geophysics who is regarded as one of the world's leading seismologists, has been named to the Robert E. Shrock Professorship in which he succeeds Frank Press, now president of the National Academy of Sciences. A native of Japan, Professor Aki came to M.I.T. in 1966 from the California Institute of Technology and the University of Tokyo; he now holds a concurrent appointment as distinguished visiting professor at the University of Alaska. The Shrock Professorship was given in 1970 by Mr. and Mrs. Cecil Green ('23) in honor of the former head of the department.

XIV

Economics

Barend A. de Vries, Ph.D.'51, reports on four alumni now at the World Bank. "We get together occasionally to share our common background and exchange our experiences in diverse areas:

☐ **Kenneth Bohr,** '50, retired from the World Bank in March 1982. He had held several positions at the bank and worked extensively in India (where he was a resident advisor); most recently he was a chief evaluation officer in the bank's Operations Evaluation Department.

From the same vintage, all M.I.T. Ph.D.'s in industrial economics, three others continue at the World Bank:

☐ **George Baldwin,** Ph.D.'52, is senior economist, Projects Department, East Asia and Pacific Region;

☐ **Sidney E. Chernick,** Ph.D.'56, is assistant director, Country Policy Department; and

☐ Barend A. de is Vries, is senior policy advisor, Industrial Department."

Frank C. Colcord, Jr., Ph.D.'64, reports that he was appointed dean of the faculty of Arts and Sciences at Tufts University in July 1981. . . . **Larry L. Orr,** Ph.D.'67, director of the Office of Technical Analysis for the U.S. Department of Labor and a 1963 graduate of Iowa State University, received that university's College of Sciences and Humanities Citation of Merit on ISU alumni day (June 5).

XV

Management

To neutralize the ulimate threat to human welfare in man's insatiable demand for energy, **Carroll L. Wilson,** '32, Mitsui Professor Emeritus, has called for "a concerted pursuit" of climate-resistant crops. In a lecture in Nairobi on May 14 as he received the 1982 John and Alice Tyler Ecology/Energy Prize, Professor Wilson explained: There are no prospects for a "technical fix" of the carbon-dioxide problem; man's sustained consumption of fossil fuels is likely to significantly increase the carbon-dixoide content of the atmosphere by the end of this century, and this in turn is likely to cause important changes in world climate. Hence his call for prompt adoption of "strategies that increase the resilience of agricultural systems to environmental stresses, including climate changes," Professor Wilson said. In contrast to other possible ways of managing CO_2 emissions, for example, genetic improvements are "well within what we know how to do and what we can afford."

James H. Ransom, S.M.'65, former vice-president of People's Energy Corp., has accepted a similar position with the Chicago, Ill., office of Management Analysis Center, an international management consulting firm focusing on implementing strategic change in complex organizations. . . . **Lawrence P. Schoen,** S.M.'72, is currently vice-president and chief bullion dealer for the Rhode Island Hospital Trust Bank. . . . **Erskine N. White, Jr.,** S.M.'49, who heads his own consulting firm, was elected a director of the Carlisle Corp., Cincinnati, Ohio, a maker of roofing, bicycle tires, specialty wire, and other products. . . . **John Norris Maguire,** S.M.'60, is chairman, president and chief executive officer of Software AG of North America, Reston, Va., a computer software products firm which went public last year.

Stephen D. Donahue, S.M.'65, reports, "The Donahues have returned to Cincinnati after completing a series of assignments with Procter and Gamble International in England and Spain. The most rewarding experience was a five-year project to locate and start up a new synthetic detergent plant in the city of Cordoba. The latest in systems analytic techniques were used to find the optimal plant location, and the latest organization design concepts were employed to set up a plant where worker teams have a high degree of autonomy. Sloan grads can be good at both!" . . . **Cameron L. Smith,** S.M.'65, writes, "I have just joined Technology Development International Corp., a Boston-area firm specializing in helping both private- and public-sector organizations to develop their international activities. We're going beyond consulting, into such fields as arranging venture capital financing and joint ventures. Hope especially to involve some non-U.S. M.I.T. alumni in our activities." . . . **Perry D. Cohen,** Ph.D.'79, reports, "I am living in Washington, D.C., with my wife Rosalie and two children Shayna (2 1/2) and Jonah (6 months). I have been doing consulting to government and industry in the areas of planning and organization development with my own firm, Perry Cohen Associates. I have recently been elected president of the Manpower Analysis and Planning Society of Washington, a professional society for human resource planners and analysts."

Frank Batchelor, S.M.'73, is currently a regional sales manager for Mannesmann Tally, a manufacturer of computer printers and intends to relocate back to Boston. . . . **Richard A. Baehr,** S.M.'75, was promoted on January 1, 1982,. to chief operating officer of Amherst Associates, Inc., Highland Park, Ill.

Sloan Fellows

Peter J. Wolfe, S.M.'73, most recently senior vice-president with primary responsibility for international operations and systems at Citibank, has been named senior vice-presient of Home Insurance Co., New York City. He will have senior management responsibility for the design, monitoring, and control of all processing activities. . . . **Ralph L. Hennebach,** S.M.'53, has been named chairman and chief executive officer of Asarco, Inc., New York City, a leading nonferrous metals producer with interests around the world. . . . **Kay R. Whitman,** S.M.'75, general manager of the Photographic Division of Eastman Kodak, Rochester, N.Y., has been elected a director of the company, and **J. Phillip Samper,** S.M.'73, general manager of the Photographic Marketing Group and manager of international photographic operations, was elected a group vice-president.

David K. Easlick, S.M.'55, president and chief executive officer of Michigan Bell Telephone Co., has been elected a director of the Sealed Power Corp., Muskegon, Mich., a maker of auto parts.

Senior Executives

S. Allan Heininger, '69, vice-president-corporate plans and business development of the Monsanto Co., St. Louis, Mo., has been elected a director of the Industrial Research Institute, Inc., New York City. . . . **Harvard D. Elverum,** '68, components group vice-president for Honeywell, Inc., has been elected a director of Buckbee Mears Co., St. Paul, Minn., a maker of lenses and precision parts.

XVI
Aeronautics and Astronautics

Rear Admiral **Delmar S. Farhney,** S.M.'30, a U.S. Naval Academy graduate, is the author of "The Genesis of the Cruise Missile" in the January 1982 issue of *Astronautics and Aeronautics.* In the biographical sketch accompanying the article Admiral Fahrney is characterized as "the father of the guided missile." During the years of 1936 to 1950 (except for a tour of duty in the South Pacific during World War II), he headed the Bureau of Aeronautics programs for target drone and guided missile developments. Under his guidance and direction "this country's first radio-controlled flight of a full-scale airplane without a human pilot was made in December 1937, the first successful test in the world of a surface-to-surface guided missile under radio control and television guidance was conducted in April 1942, and the first successful test in the world of an air-to-surface guided missile was carried out in September 1938." Admiral Fahrney retired from active service in 1950 and now lives in La Mesa, Calif.

James F. Glass, S.M.'75, is currently employed as project engineer for computing analysis at Rocketdyne Division of Rockwell International. He's working on advanced engine designs for future space vehicles. . . . **James K. Marstiller,** S.M.'47, reports, "I am with the U.S. Army Aviation Research and Development Command (AVRADCOM) at St. Louis, Mo., since 1974 as an engineer on the remotely piloted program. I handle the international activities which have taken Jane and me to Europe several times. Our youngest, John, graduated from Purdue in May in aero."

William S. Beebee, Sc.D.'75, is currently manager of operations analysis for the Bendix Guidance Systems Division, Teterboro, N.J. . . . **Peter M. Bainum,** S.M.'60, writes that he has been reelected for a second term as first vice-president of the American Astronautical Society (October 1981) and was the recipient of the Award for Outstanding Research given by Howard University (1980-81). . . . **Arthur J. Wennerstrom,** S.M.'58, chief of the Compressor Research Group, Aero Propulsion Laboratory, Wright-Paterson Air Force Base, Ohio, has been named a fellow of the American Society of Mechanical Engineers. He is also a fellow of the American Institute of Aeronautics and Astronautics, a holder of five patents, the U.S. coordinator for the NATO/AGARD Propulsion and Energetics Panel, an associate editor of the *AIAA Journal,* and is a member of the ASME Gas Turbine Division's Executive Committee.

XVII
Political Science

Anne M. Grazewski, administrator of graduate student affairs in political science, won a 1982 James N. Murphy Award for "spirited contributions to the Institute, especially with regard to students." Ms. Grazewski's nominator wrote, "No matter what problem I've brought before her, she has listened to me with the patience of Job, and answered me with the wisdom of Solomon."

Professor **Robert I. Rotberg,** editor of the *Journal of Interdisciplinary History,* has just completed his assignment as co-chairman (with Professor **Nevin S. Scrimshaw** of the Department of Nutrition and Food Science) of a Conference on Hunger and History at the Rockefeller Foundation's Bellagio Conference Center in Northern Italy. The idea, according to Professor Rotberg, was to develop a better understanding of the impact of hunger, food scarcity, and nutritional trends in man's past—especially on the performance of societies over time. The conference was made possible by a Rockefeller Foundation grant to the magazine, and proceedings will be published in a special number of the journal (M.I.T. Press) and in a book (Princeton University Press).

Latin American nations have demonstrated "impressive ability to adapt" to the new international and domestic environment created by the world's changing energy situation, and they're not often given credit for this achievement in adaptation and change, writes Professor **Nazli Choucri** in her new book *Energy and Development in Latin America* (Lexington, Mass.: Lexington Books—D.C. Heath and Co., 1982). The result has been "substantial gains for Latin America in the international arena . . . new patterns of trade, aid, and cooperation . . . new opportunities for greater leverage on international issues . . . and greater regional integration." . . . **Anne H. Cahn,** Ph.D.'71, reports that she has become executive director of the Committee for National Security.

XVIII
Mathematics

Professor **Herman Chernoff** was among the National Research Council's committee of experts who reported late in the spring that "reliable acoustic data do not support a conclusion that there was a second gunman" involved in the death of President John F. Kennedy in Dallas in 1963. "The acoustic analyses," said the committee, "do not demonstrate that there was a 'grassy-knoll' shot." Other members of the committee included **Jerome I. Elkind,** '51, of the Xerox Palo Alto Research Center and Charles Rader of the M.I.T. Lincoln Laboratory.

XIX
Meteorology

Peter R. Tatro, Ph.D.'66, is currently corporate vice-president and manager of the Technology and Ocean Sciences Department at Science Applications, Inc., McLean, Va. . . . **James R. Holton,** Ph.D.'64, professor of atmospheric sciences at the University of Washington, Seattle, received the American Meteorological Society's second highest honor, the Second Half Century Award, for excellence in contributions to both and atmospheric and oceanographic studies. Dr. Holton is described as "an expert meteorologist on the theory of fluid motions."

XX
Nutrition and Food Science

Two major awards came to members of the department during the annual meeting of the American Institute of Nutrition in New Orleans early last spring:

☐ To Dr. **Richard J. Wurtman,** professor of neuroendocrine regulation, the Osborne and Mendell Award of the Nutrition Foundation for outstanding recent basic research in which he has "originated the research area of nutrition and brain function."

☐ To **Vernon R. Young,** professor of nutritional biochemistry, the Borden Award in Nutrition of the Borden Foundation for contributions to nutrition research—"a world leader in protein quality evaluation," said the citation.

Hamish N. Munro, adjunct professor of physiological chemistry at M.I.T. who is director of the U.S. Department of Agriculture's Human Nutrition Research Center on Aging at Tufts University, Boston, holds the 1982 J. Arthur Rank Foundation Prize for outstanding research in human nutrition. The $40,000 award was given to Dr. Munro for "significant work in defining the balance of nutrients required as the human body grows older."

Bill Kan, Ph.D.'57, writes that "in a natural symbiosis with my Access Group search and placement activities, I have for three years been running the Fairfield County, Conn., summer job program for M.I.T. students. Contact me in Stanford if you have some openings." . . . **Susan Kampmeier Stein,** S.M.'73, writes, "I am currently consultant to the Cystic Fibrosis Center of South Florida, University of Miami School of Medicine, while nurturing two daughters, Janet Sonia (age seven months), and Ada Laura (age three and a half years, who recently successfully completed a smooth course of chemotherapy and other treatment for kidney sarcomatous tumor). My husband, George is currently a reporter on higher education and vice presidential commission on crime for the *Miami Herald.*" . . . **Susan Alfano Van Der Vynckt,** S.M.'73, has been appointed by the director-general of the United Nations Educational, Scientific and Cultural Organization to the post of program specialist in nutrition education in the Division of Science, Technical, and Vocational Education at the UNESCO secretariat in Paris, responsible for planning and execution of UNESCO's programs in the fields of nutrition, health, and home economics education.

XXI
Humanities

Three members of the department have received research fellowships from the American Council of Learned Societies for 1982-83:

☐ **Kathryn J. Crecelius,** assistant professor of French, for studies of George Sand's narrative strategies between 1830 and 1839.

☐ **Amy S. Lang,** assistant professor of literature, for research on the evolution of Anne Hutchinson as a literary figure.

☐ **Peter S. Donaldson,** associate professor of literature, for his project on the Machieavellian mystery of state.

XXII
Nuclear Engineering

Professor **Michael J. Driscoll,** Sc.D.'66, holds the 1982 Irwin W. Sizer Award for contributions to improved educational programs at M.I.T.; Professor Driscoll was cited with Professor **Kenneth R. Manning** of the Program in Science, Technology, and Society for efforts to establish a new undergraduate writing requirement.

Martin Becker, Ph.D.'62, professor of nuclear engineering at Rensselaer Polytechnic Institute, received the American Society for Engineering Education's 1982 Glenn Murphy Award. The award recognizes "a distinguished nuclear engineering educator for notable professional contributions to the teaching of undergraduate and/or graduate nuclear engineering students." . . . **William R. Corcoran,** Ph.D.'71, director of plant engineering at Combustion Engineering, Inc., Windsor, Conn., has been named a fellow to the American Nuclear Society in recognition of "his significant contributions toward the safe utilization of nuclear power in the areas of engineering design, operations, and licensing and regulation."

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Puzzle Corner
Alan J. Gottlieb

Wanted: Quickies Quick

Allan J. Gottlieb, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institue, New York University, 251 Mercer St., New York, N.Y. 10012.

Alice and I want to thank everyone for their kind words in response to our birth announcement and are pleased to add that our newly expanded family is doing just fine.

I had intended, in that same (May/June) issue, to note a critical shortage of speed problems, but somehow that portion of the introduction to "Puzzle Corner" did not appear. Thus I must now use the last two "speed problems" from my files and must ask you to submit some new quickies quick.

Problems

A/S 1. Matthew Chen has a problem that uses less than one-third of a chess board and one-eighth of each army. Place white bishops on a1 and a3 and place black bishops on e1 and e3. By moving each color alternately, such that a black bishop can never take a white one and conversely, and restricting moves to ranks 1 to 4 and files a to e (i.e., to ten black squares), exchange the position of the bishops so that the black bishops end up on a1 and a3 and the white bishops on e1 and e3.

A/S 2. Emmet Duffy asks the following geometry question. An isosceles triangle has a bisector of one of the two equal angles that is 6 inches long. If the base is 5 inches, without using trigonometry, find the length of the two equal sides.

A/S 3. Steve Chilton asks an interesting question about primes. Write the prime numbers and take successive absolute differences

```
2 3 5 7 11 13 17 19 23 ...
  1 2 2 4  2  4  2  4 ...
```

Note that the second row starts with a 1. Next repeat the process of taking successive absolute differences obtaining

```
2 3 5 7 11 13 17 19 23 29 ...
  1 2 2 4  2  4  2  4  6 ...
    1 0 2  2  2  2  2  2 ...
      1 2 0  0  0  0  0 ...
        1 2  0  0  0  0 ...
          1 2  0  0  0 ...
            ...
```

The problem is to prove or disprove that the series of leading 1's continues forever.

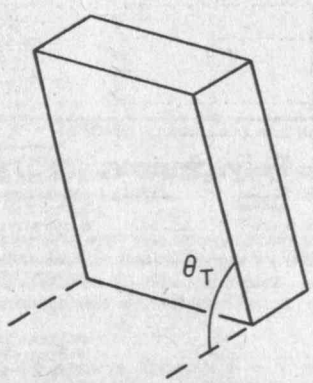
A/S 4. John Fogarty has sent us the "rug puzzle." You want to put wall-to-wall carpeting into a room that is 9x12 feet. You have two pieces of carpet, one 10x10 and the other 1x8. These do add to the correct square footage, but obviously the 10x10 must be cut. The challenge is to devise *one continuous* cut through the 10x10 piece such that the two resulting pieces will exactly fit the 9x12 area with one gap left over into which the 1x8 remnant can fit to complete the job.

A/S 5. Our last regular problem is reprinted from the M.I.T. Physics Department student newsletter edited by Minn Chung:

On one rainy day Fat Timothy was riding a donkey in the countryside ten miles away from the nearest shelter when he was caught in a strange rain which had a uniform mass density and fell straight down. Worried about being exposed to this strange precipitation, Timothy rode the faithful donkey as fast as he could to the nearest shelter. Assuming that the speed of the donkey was uniform and sufficiently high, find:

1. The amount of rain which fell on Timothy as a function of θ_T, the angle Timothy's body makes with the ground.
2. The minimum and maximum amount of rain which might fall on Timothy.
3. The ideal situation in which Timothy would be wet least.

Approximate Timothy's body as a box:



Speed Department

SD1. Daniel Seidman wants you to find the next term in each of the two (related) sequences.

```
3 4  8  9 14 23 __
2 9 10 18 20 28 __
```

SD2. We close with an offering from Smith Turner. Financial types have a rule for how long it takes money at compound interest to double [assuming the interest is compounded yearly—ed.]: years equals 72 divided by the interest rate. For example, at 6 percent, 72/6 = 12 years. What is the mathematical basis for this "rule" and how good an approximation is it?

Solutions

M/A 1. Can the following contract be made against any defense?

	♠ 7,3,2 ♥ 5,4,2 ♦ A,10,9,7,6	
♠ K,6,4 ♥ K,J,7,6 ♦ K,J ♣ K,Q,J,5	♣ 3,2	♠ 8 ♥ 9,8 ♦ 8,5,4,2 ♣ 10,9,8,7,6,4
	♠ A,Q,J,10,9,5 ♥ A,Q,10,3 ♦ Q,3 ♣ A	

The bidding:

South:	*West*	*North*	*East*
1 spade	double	2 diamonds	-
3 spades	-	4 spades	5 clubs
5 spades	double	-	-

We begin with a solution from Amy Lowenstein: The only way West can defeat South is by sacrificing his ♦K, ♠K, and all his club honors; and West must lead the ♦K or else South has all the timing he needs. If West leads anything but the ♦K, South has time to knock out the ♠K and still get to dummy with the ♦A to run diamonds. The probable scenario goes like this: West leads ♦K, South takes with dummy's ♦A, than leads ♦Q and ♣A on which West must take care to throw an honor and not the ♣5. South will try to make dummy's ♠7 an entry by leading the ♠Q, but West will duck. South will lead the ♠J, but West will still duck; so South will then take the ♠A, felling West's ♠K. At this point South should run off two more spades. East should throw diamonds on the spades, and then throw clubs; East must keep both his hearts to avoid West's possibly being end-played by South with the ♥3 to West's ♥7. On the run of the spades, West must throw both club honors. Finally South will play the ♥10, which West will win with the ♥J, but West can get out with the ♣5 to his partner's ♣10. South can ruff or not, but eventually West must make his ♥K. If South has not ruffed the club trick just mentioned, South's three losers are the ♥J, ♥K, and ♣10. Even if South ruffs that club, he still winds up losing the ♥K and ♥7 as the other two losers besides the ♥J, so he is still down one.

Also solved by Gardner Perry, Randy Haskins, John Schindler, John Bobbit, Ronnie Selbst, John Woolston, Richard Hess, Joel Feil, Matthew Fountain, Robert Bart, Winslow Hartford, Warren Himmelberge, and the proposor. Frank Model.

M/A 2. Given 39 balls of which 38 are identical in weight but the 39th is either heavier or lighter than the others, isolate the "odd" ball with only four weighings using a balancing scale. The weighings should also establish if the odd ball is heavier or lighter than the others.

T. Landale sent us a well-organized solution, and Martin Langerveld conjectures that with n weighings the maximum number of balls is $3^{(n-1)} + 3^{(n-2)} + \ldots + 3^1$.

Mr. Landale's solution follows:

The solution is easier to understand if the most common "end game" is described first. This game is with three balls, it being known from previous weighings that (1) one of the three, but not which one, is the odd ball; and (2) for each of the three balls, whether it is heavier or lighter than the others. On the scale compare two balls, each of which is known to be heavier or lighter, if odd. If the scale does not balance, the odd ball is the heavier or lighter one, as the case may be. If the scale does

Weighing	Previous Result (Balance)	(Scale position)	Balls each side	Balls on scale (Left)	(Right)	Solution
A			13	1-13	14-26	
B	if (A) ≠		9	1-6, 14-16	7-12, 17-19	
C	if (B) ≠	& (B) as (A)	3	1, 2, 17	3, 4, 18	
D	if (C) ≠	& (C) as (A)	1	1	2	* 1, 2 or 18
D	if (C) ≠	& (C) not as (A)	1	3	4	* 3, 4 or 17
D	if (C) =		1	5	6	* 5, 6 or 19
C	if (B) ≠	& (B) not as (A)	3	7, 8, 14	9, 10, 15	
D	if (C) ≠	& (C) as (A)	1	7	8	* 7, 8 or 15
D	if (C) ≠	& (C) not as (A)	1	9	10	* 9, 10 or 14
D	if (C) =		1	11	12	* 11, 12 or 16
C	if (B) =		3	20-22	23-25	
D	if (C) ≠	& (C) as (A)	1	23	24	* 23, 24 or 25
D	if (C) ≠	& (C) not as (A)	1	20	21	* 20, 21 or 22
D	if (C) =		2	13, 26	(1, 2)**	13 if (D) as (A) 26 if (D) not as (A)
B	if (A) =		9	27-35	(1-9)**	
C	if (B) ≠		3	27-29	30-32	
D	if (C) ≠	& (C) as (B)	1	27	28	27, 28 or 29
D	if (C) ≠	& (C) not as (B)	1	30	31	30, 31 or 32
D	if (C) =		1	33	34	33, 34, or 35
C	if (B) =		3	36-38	(1-3)**	
D	if (C) ≠		1	36	37	* 36, 37 or 38
D	if (C) =		1	39	(1)**	39 as weighed

balance, the odd ball is the third ball, and it is heavier or lighter as already known. Now proceed to the full solution, where an asterisk (*) signifies this common "end game."

Identify the 39 balls as 1 through 39 and the four weighings as A through D, and proceed according to the table at the top of this page. (At the points marked with the double asterisk (**), use any balls known to be not odd.)

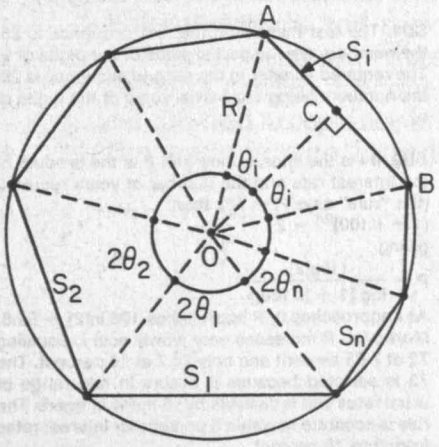
Clearly this is not a unique solution. For example, (D) following (A) ≠, (B) =, and (C) = can be solved simply by weighing (13) or (26) against one ball known not to be odd. Also, (B) following (A) = can lead to solution weighing six balls each side: 27-32 vs. 33-35 plus three balls known not odd; there are other arrangements which will solve (B) following (A) = as well.

Also solved by Robert Bart, Matthew Fountain, Richard Hess, John Woolston, Thomas Peterson, Joe Feil, Ronnie Selbst, Ken Arbit, John Bobbit, John Rule, Frank Carbin, Emmet Duffy, Norman Spencer, Walter Smith, Edgar Rose, and the proposer, Arun Trikha.

M/A 3. Given the lengths of the n sides of an irregular polygon, how should the sides be arranged and what should the angles be in order to maximize the area?

Harry Zaremba sent us the following carefully drawn solution:

The maximum area that can be enclosed by an irregular polygon occurs when each vertex lies on a circle circumscribing the polygon. The radius of the circle and polygonal area remain unchanged for any peripheral combination of the given sides of the inscribed polygon. The maximum area which can be confined within a given n-gon may be determined by the following analysis.



In the figure shown,
R = radius of the circle circumscribing the n-gon.
S_i = length of the ith side of the n-gon. (i = 1,2,3, . . ., n).
$2\theta_i$ = angle subtended by S_i at center O of the circle.

For the indicated ith triangle AOB, OC = R cos θ_i and

$S_i = 2R \sin \theta_i$, or

$R = S_i/(2 \sin \theta_i)$ (1)

The area of AOB is

$A_i = (S_i/2)R \cos \theta_i = (S_i^2/2) \cot \theta_i$.

Therefore, the total area of the polygon becomes

$A = \frac{1}{4}(S_1^2 \cot \theta_1 + S_2^2 \cot \theta_2 + \ldots + S_n^2 \cot \theta_n)$. (2)

Also from the figure, the sum of one-half of the central angles is

$\theta_1 + \theta_2 + \theta_3 + \ldots + \theta_n = \pi$. (3)

Using equation (1), the ratio of the expression for the ith side to that for side S_1 yields

$S_i/S_1 = (\sin \theta_i)/(\sin \theta_1)$, or

$\theta_i = \sin^{-1} (S_i/S_1) \sin \theta_1$ (4)

Substitution of θ_i into (3) for i = 2,3, . . ., n results in

$$\theta_1 + \sin^{-1}\left(\frac{S_2}{S_1}\sin\theta_1\right) + \sin^{-1}\left(\frac{S_3}{S_1}\sin\theta_1\right) + \ldots + \sin^{-1}\left(\frac{S_n}{S_1}\sin\theta_1\right) - \pi = 0 \quad (5)$$

The solution to equation (5) can be obtained readily by iteration methods to any practical accuracy with the use of a computer or programmable calculator. With θ_1 determined, all other angles θ_i, maximum area A, and radius R of the circle can be evaluated from equations (4), (2), and (1), respectively. For example, when n = 5 and sides S_1 to S_5 equal 5, 4, 3, 2, and 1, respectively, the central half angles are:

$\theta_1 = 66°55'2.6''$
$\theta_2 = 47°23'15.9''$
$\theta_3 = 33°30'6.7''$
$\theta_4 = 21°35'27.1''$
$\theta_5 = 10°36'7.7''$

and the area A = 13.60499 square units and the radius R = 2.717567.

Also solved by Matthew Fountain, Robert Bart, and the proposer, Irving Hopkins.

M/A 4. In how many ways can seven people be seated at a round table so that no person sits next to the same pair (unordered) of people twice?

Several readers pointed out that for n people, at most

(n - 1)(n - 2)/2

arrangements are possible. Thus for n = 7 we obtain an upper bound of 15. Apparently the exact value is not known. Most responders found 10 arrangements, but Ken Arbit found the following 11.

1, 7, 6, 5, 4, 3, 2	1, 6, 4, 7, 3, 2, 5
1, 5, 6, 4, 3, 7, 2	1, 3, 6, 7, 5, 4, 2
1, 5, 4, 6, 3, 2, 7	1, 3, 4, 2, 6, 5, 7
1, 4, 7, 5, 3, 6, 2	1, 6, 3, 7, 5, 2, 4
1, 7, 4, 5, 3, 2, 6	1, 3, 7, 6, 2, 5, 4
1, 6, 7, 4, 3, 5, 2	

Also solved by Matthew Fountain, Richard Hess, Gardner Perry, and Harry Zaremba.

M/A 5 We begin with two integers m and n such that $2 \leq m \leq n \leq 99$.
We tell Mr. P the product mn, and we tell Ms. S the sum m + n. the following conversation then takes place:
Mr. P: "I don't know the two numbers."
Ms. S: "I knew you didn't know. I don't know either."
Mr. P: "Now I know the numbers."
Ms. S: "Now I know, too."
What are m and n?

Mark Lively had little trouble with this one but admits surprise at the high level of civilization now found at M.I.T.

'Mr. P: "I don't know the two numbers" ' precludes m and n from being both prime, since their product would then be factorable in one way only, as the two primes, and the answer be transparent to Mr. P.

'Ms. S: "I knew you didn't know, I don't know either" ' precludes m and n from summing to any number equal to the sum of two primes. For example, "4,4" would be revealed to Ms. S as "8". The revelation of an "8" to Ms. S does not preclude "3,5" which would be communicated to Mr. P as "15", revealing the answer to Mr. P. Similarly, all m and n's summing to greater than "54" are precluded, since they would allow "53,n" and a transparent answer for Mr. P. Ms. S's number must be "11,17,23,27,29,35,37,41,51, or 53."

'Mr. P: "Now I know the numbers" ' precludes the product from having more than one pair of factors $f_i g_i$ whose sum appears in the above list. Thus Mr. P's number cannot be "30" since that allows "2,15" and "5,6", both of whose sums "11" and "17" appear in the list.

'Ms. S: "Now I know, too" ' precludes the sum from having two items not eliminated in the above. The sum "11" permits "2,9" (product "18"); "3,8" (product "24"); "4,7" (product "28"); and "5,6" (product "30"). Since only the latter combination was eliminated by Mr. P's statement, the first three are eliminated by Ms. S's statement.

The answer is 4,13. Your statement of the problem seems longer (and more civilized) than I would expect from my fellow students. A shortened version follows:
Ms. S: "You don't know the answer."
Mr. P: "Now I do."
Ms. S: "So do I."

Also solved by Sidney Shapiro, Carl Goodwin, Elliot Roberts, John Bobbit, Richard Hess, Matthew Fountain, Ken Arbit, Ronnie Selbst, John Woolston, Amy Lowenstein, Douglas Fink, Michael Jung, Frank Norton, Win Haviland, Bryan Sayrs, Edwin McMillan, and Robert Bart.

Better Late Than Never

FEB 1, Feb 3, and **FEB 5.** Allen Tracht has responded.

Proposers' Solutions to Speed Problems

SD1. The last number in the first sequence is 25; the numbers are the partial sums of the digits of π. The required number in the second sequence is 29, the numbers being the partial sums of the digits of e.

SD2. If i is the interest rate and P is the product of the interest rate and the number of years required (the "rule" says P = 72), then

$$(1 + i/100)^{P/i} = 2$$

giving

$$P = \frac{i \log(2)}{\log[1 + (i/100)]}$$

As i approaches 0, P approaches 100 ln(2) = 69.3. Moreover, P increases very slowly with i, equaling 72 at 7.85 percent and only 74.7 at 16 percent. The 72 is selected because it occurs in mid-range of usual rates and is divisible by so many integers. The rule is accurate to within 5 percent for interest rates from 2 to 18 percent.

Technology's Fertile Soil

Few people willingly use high-technology products made in communist states and other countries with centrally planned economies, and those countries are ever eager to get goods growing out of the superior technology of the free nations. In a world where free enterprise seems little revered of late, this is a point worth reflecting on.

Centrally planned societies can focus their efforts and resources well in a few product areas, such as weapons, and succeed spectacularly in special "big technology" projects such as space satellites. Their scientists are certainly among the best. But most of their products fall far short of free-world standards not only in quality but in basic technology.

A central reason is that technology flourishes best in free societies like ours that promote frequent change responsive to people's wants.

A dynamic society continuously generates both the need for new or improved products and the means to produce them. Free nations advance technology so fast that inventions seem to be put on the market one day and in museums the next as technology is improved.

Our free society stimulates all producers to assess product possibilities thoroughly and risk innovation at every opportunity, while discouraging both ill-considered moves and thoughtless inaction. Freedom is the environment in which the fittest technology evolves and survives.

Anyone who improves a product or develops a needed new one as soon as practical can find acceptance in the marketplace. But anyone who introduces technology not wanted by enough customers at the time could lose a lot of money. Notable miscalculations of recent years include synthetic shoe leather and instant movies.

On the other hand, if companies don't make improvements or developments quickly enough they may lose business to competitors, as many watchmakers discovered when they stood by while other companies developed battery-powered models.

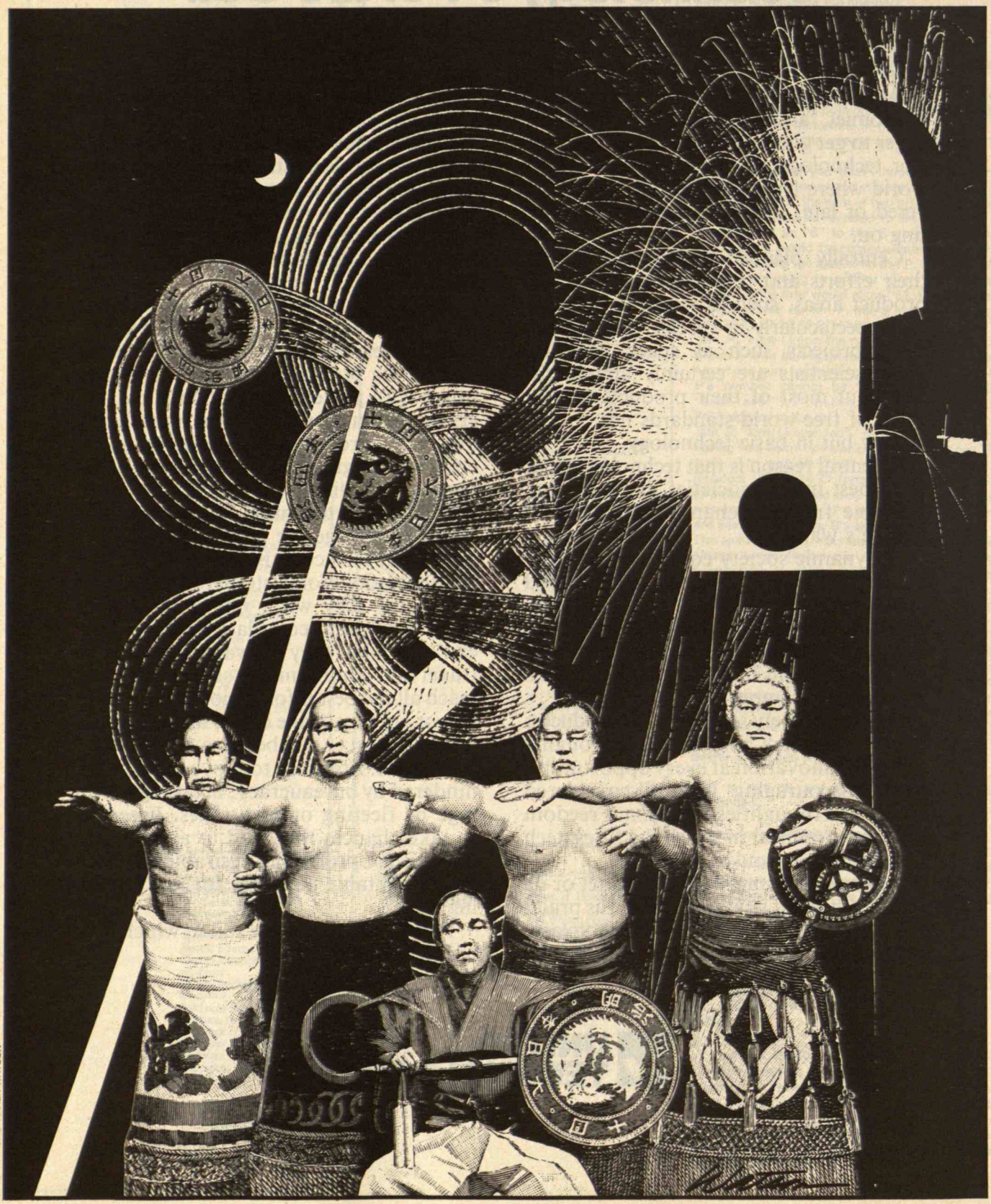
This balance of incentives and disincentives keeps us sharp, constantly alert to realistic new prospects for manufacturing and selling products. We have to stay in touch with present and potential customers to remain keenly aware of what they'll buy, and carefully watch progress in science and engineering to spot useful advances immediately. We invest heavily in fundamental technical disciplines ourselves to enlarge the possibilities.

The key to success in technology is freedom. Freedom for customers to buy from whomever they wish, ignore what they don't want, and complain loudly if they can't get what they do want. Freedom to travel and communicate so everyone can reach all the best information. Freedom to buy or not buy, make or not make, because it seems best—not because it's dictated by politics. Freedom to move quickly, unhindered by bureaucracy, in taking advantage of fleeting opportunities. Freedom to take chances that lead to appropriate rewards for producing desirable technology and suitable penalties for not producing it.

Free enterprise is the soil in which technology grows best.

UNITED TECHNOLOGIES

More by accident of culture than managerial design, the Japanese have achieved a unique form of industrial democracy. But many stumbling blocks to their continued success are on the horizon.



ILLUSTRATIONS: KAREN WATSON

Can the Japanese Keep It Up?

by Richard D. Robinson

EVIDENCE for the high productivity of Japanese workers and the effectiveness of Japanese industry is everywhere. Without any windfalls in raw materials, Japan has maintained a healthy trade surplus for many years while making a demonstrable improvement in its people's general standard of living. This is a remarkable achievement; clearly Japan's productivity has been increasing more rapidly than that of many, if not most, of its major trading partners.

Japan uses about 2.6 times less energy per capita than the United States, and it is far behind most other industrialized countries in measures such as housing, sewerage, parks, and percentage of paved roads. But the standard of material well-being in Japan is approaching that of Europe and North America, and Japan's wealth may be more evenly distributed than in many countries. Though social investment has fallen far behind, savings have been maintained at unusually high levels (probably three times those of the United States), and the per capita tax burden in Japan is 20 percent compared with 30 percent in the U.S.

Average Japanese life expectancy at birth was the longest in the world in 1981—73.5 years for men and 78.9 years for women, compared with 68.7 and 76.5 years, respectively, in the United States. Crime rates are very low. On a per capita basis, Japan has about one-seventh as much litigation and one-sixteenth as many lawyers as the U.S. Life in Japan is comfortable and apparently satisfying—the Japanese live elsewhere reluctantly.

Good Planning or Hard Work?

Some of the extraordinary success of Japanese industry and agriculture can surely be attributed to three unusual circumstances. Over the past 20 years Japan has spent but 1 percent of its gross national product on the military—about $1 trillion less than the United States in the same period. Japan has no antitrust laws that effectively restrict combinations of manufacturing companies, banks, and trading companies. And the Japanese tend to follow a much-publicized—but little understood—system of management that in some respects is very different from U.S. practice.

But there is no simple explanation for the prodigious growth of Japanese industry in the last three decades, and one is tempted to attribute this success to cultural or even racial traits: Can it be that the Japanese simply work harder? (No doubt many Japanese work long hours, but why do they? And do long hours equate with high productivity?) Or are the Japanese more ingenious and creative? (But that also begs a question: Why? For they were not always that way.)

Permit me to offer my own explanation of the remarkable productivity increases characteristic of modern Japan, and to list my reasons for suspecting that this improvement is unlikely to continue at anything like the present pace. I have visited Japan repeatedly since the end of World War II, including especially the summer of 1981, when I interviewed approximately 80 Japanese executives and professors of economics, law, and management. In addition, from 1981 to 1982, ten of my students studied a sample of firms in the United States taken over or established by Japanese corporations. They sought to discover the extent to which Japanese management philosophy and practice has been applied, and with what effect. (The most recent tally of such enterprises was 213 at the end of 1980, plus 12 others in which the Japanese held a

The demands of employees everywhere for greater control of their work lives and their enterprises is now irrepressible.

minority interest of at least 10 percent. These 225 companies operated 314 plants in the United States, representing about $6.5 billion of direct Japanese investment as of the end of 1981.) The point is, of course, that if Japanese-owned firms here do better than their U.S. counterparts, then the impact of Japanese management may be significant, and the demonstrably higher Japanese productivity may not be due entirely to environmental advantages.

A Sense of Personal Involvement

Unbridled praise in the popular literature for Japanese productivity and enthusiasm for the management system that allegedly makes it possible does the United States a grave disservice on three counts. Many of the more salient aspects of the Japanese experience are rarely mentioned, the serious problems now surfacing in Japan are discussed inadequately if at all, and the authors often naively project the trends of the recent past into the future.

The Japanese "management system" is said to be based on traditions and policies that confer on Japanese corporations a kind of social welfare role, including life-time employment, consensus decision making, seniority-based promotion and reward, strong company loyalty, company unions, and quality-control circles. Japanese companies are said to enjoy an atmosphere of harmony among government, business, and labor and to be characterized by high ratios of debt to equity in their financing, extensive subcontracting that restrains vertical integration, and resistance to diversification. All these characteristics are present to a degree, but a simple listing says little about what makes the system work. In fact, there is much variation from firm to firm—one can make only a few generalizations.

Everyone Puts In Some Time

In Japan virtually no one expects to obtain an entry-level managerial position at a relatively high salary immediately after receiving a master's degree in business administration. There is, in fact, only one MBA program in all of Japan, and in 1981 it had a total of only 50 students—47 men, 3 women. When Japanese corporations hire new employees, they hire individuals—not technical specialists. Almost all new employees start in menial jobs, and all have a shot at management. University graduates, particularly those from the prestigious schools, do constitute something of an elite—the old-college-tie connection does help—but apparently it is important only for those who demonstrate competence and even then only after a decade or more. Few become managers with less than 15 to 20 years of employment.

Between 10 and 25 percent of all top Japanese executives—the percentage varies with the size of the firm—were once labor-union officials, most often in their own corporate unions. Between 20 and 60 percent of all industrial firms, again depending on size, report the promotion of at least one former union official to top management. Virtually everyone—even engineering graduates—seems to have had blue-collar experience. This means that most technical specialists and managers have a personal identity with the ordinary factory worker and clerk—they have put in their time.

Salary and wage differentials are relatively narrow. In company after company, I am told that the ratio of a top manager's salary to that of an entry-level blue-collar employee is only 5 or 6 to 1. It is almost unthinkable for management to reward itself with higher salaries without providing similar increases to all employees. Management leads the way in reducing its own salaries when wages of employees must be reduced or in the unlikely event (it does happen) that workers have to be laid off.

Promotion is almost always from within. Outsiders are rarely brought in to assume authority over those with greater seniority, and new personnel are selected with great care through multiple interviews and examinations. In the case of university graduates, even in a large corporation, the president himself may be directly involved.

It is characteristic of Japanese enterprise that all employees are valued and their opinions solicited on matters within their competence, and when their activities will be affected by a change in company policy or procedures. No engineer or manager would urge changes in products or processes without close consultation with workers on the factory floor. For example, the management of a large textile firm that faced a long-term decline in the market took five years to lay off redundant labor. During that time the company conducted extended negotiations with the union, including candid discussion of the financial situation, and in the end made intensive efforts, including individual counseling, to encourage early retirement or find positions elsewhere for laid-off employees. One of the first steps was to reduce management salaries. Any Japanese corporation that

behaved differently would be perceived as performing in an unacceptable manner.

It is precisely this kind of long-term commitment and concern on the part of both labor and management that builds the identity, loyalty, and unusual level of trust and confidence typical of the Japanese firm. The common experience, the relatively narrow financial and social distance between the top and bottom, and the sense of security together make possible a system of consensus and group decision making in which the opinions of all employees are actively sought, acted upon, and rewarded. Virtually everyone at every level seems to have a sense of personal involvement and identity with work, group, corporate community, and nation.

The Whole Is Greater Than Its Parts

Many observers propose that the Japanese are relatively risk-averse, and this is consistent with the finding in our U.S. study: Japanese managers do not make decisions until all the relevant data have been assembled and analyzed, almost regardless of how much time this requires. Indeed, Japanese managers do not feel they are under time pressure as do many U.S. managers, who must respond to the demands of stockholders for progress in each quarterly and annual financial report. Owners of Japanese corporations are principally other corporations—banks, clients, customers, contractors, suppliers, trading companies. These owners' interests are in long-term success—the profitable business that comes their way—not in the short-term flow of dividends. Under these conditions, management has time to make decisions carefully.

Japanese decision makers delve into every aspect of a proposal, including human resources. For this reason, decision making becomes a highly participative process; in the end, decision and implementation become almost simultaneous. Indeed, I am told that the Japanese do not deliberately install participatory decision-making systems in U.S. operations; they simply insist on having so much data and analysis—including problems of implementation—that all employees become involved. As technology becomes more complex, consultation at this level becomes more important: essential knowledge and skills are increasingly difficult for individual managers to capture and integrate themselves.

This highly consultative process means that less authority resides in top management; the importance of the president and the directors is reduced because they do not make unilateral decisions. Everyone is important, and communication is open in both directions. The very layout of Japanese offices reflects this difference. There is also less internal competition than in U.S. companies and more communication among peers. Skill in maintaining harmony and open communication is rewarded more than sheer technical competence.

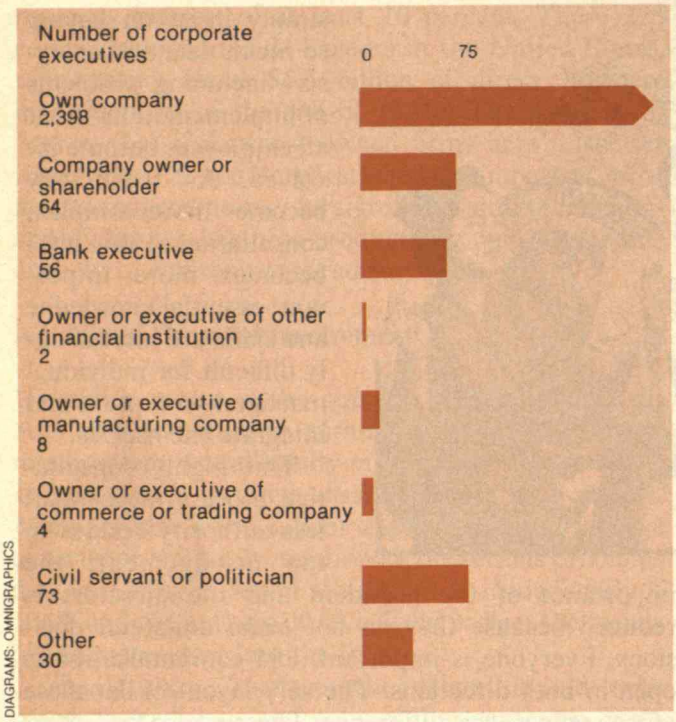
An important result of this decision-making style is that Japanese corporations, though risk-averse, may in fact be able to accept larger risks than their non-Japanese competitors. Their decisions are better because the analysis is more complete and implementation is more rapid.

The Manager Is a Worker, Too

I believe that the demands of employees everywhere—whether of private, state, or socialist enterprises—for greater control of their work lives and the strategies of their respective enterprises is now irrepressible. As levels of longevity, education, social enlightenment, skills, and affluence rise, people everywhere expect an ever-greater role in decision making and reduced socioeconomic differences. Differentials of hundreds of thousands of dollars in annual incomes between managers and workers tear at the social fabric, leading to alienation, mistrust, anger, and conflict.

What the Japanese seem to have learned is that a manager is merely another employee. Indeed, there seems to be no clear distinction between a manager

The origins of Japanese corporate executives. The task of reconstruction after World War II was left to new business leaders who had no conventions and traditions to guide them. This freedom was "a liberating influence," writes Akio Iizuka, editor of *Sentaka* (Choice), a widely read Japanese business monthly. The fact that Japanese companies were "totally equalitarian," with employees left to develop their own talents and rise on the basis of "natural selection," was "a major stimulus for Japan's postwar growth." (Chart: Japan Committee for Economic Development, from *The Wheel Extended*)



DIAGRAMS: OMNIGRAPHICS

and a nonmanager; there is no common generic term for "manager." One whose function has a higher managerial content than another is not necessarily considered more valuable to the enterprise, or to society.

I was struck by a recent statement attributed to Soichiro Honda in reference to U.S. automobile plants he had seen: "The working environment was bad. Decent people don't want to work at such places, and as a result the quality of labor at those workshops is poor."

A self-educated mechanic who started from the bottom, Honda is described as believing that the workplace should be "a place where everybody finds joy in working and earning a living. . . . An organization that enforces monotonous labor and deprives workers of the right to think may work well for a while, but it is bound to decay in the long run. . . . It is wrong for executives to act like feudal lords and not know what is going on below them. What is most important in the process of democratization is for the upper people to come down. And that is where the sense of equality is found."

But there is another side to this argument, made clear by Yaichi Ayukawa, president of Techno-Venture, speaking in Boston last winter. There is no such thing as a true venture capitalist in Japan, he said. "A genius's genius can be quickly smothered by a climate controlled by a group of average men striving for harmony." Mr. Ayukawa suggested that the highly structured nature of Japanese business and society and the reverence for consensus and team effort "are good characteristics for maintaining an existing system. But they are not good for new, diverse businesses." He noted the absence of an over-the-counter securities market in Japan, the low rate of capital accumulation and high debt of most Japanese industries, the high (40 to 50 percent) capital-gains tax in Japan, and the tendency of Japanese firms to hire generalists.

Yet the Japanese are doing something right, and the explanation seems very clear: with the reduced pressure for short-term financial return, even large corporations can become venture capitalists.

A Turning Point

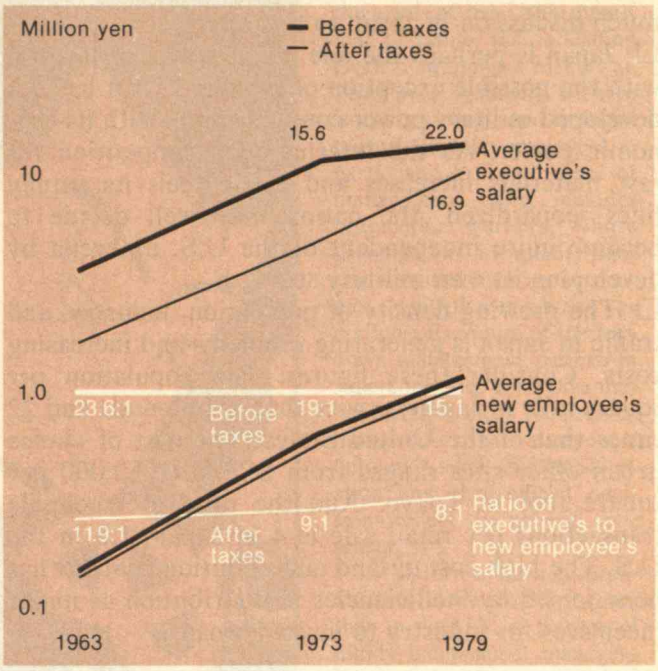
Can the Japanese economy continue to grow at the extraordinary pace of the past 20 years? There are many reasons to be cautious about the nation's future:

☐ Productivity in Japanese agriculture is unlikely to continue to improve. Japan has been virtually self-sufficient in many agricultural products during the past 20 years. But population and per capita consumption are growing, and the intensity and productivity of agriculture may well have peaked. Japan will probably be forced to import a larger share of its food in the future.

☐ Japanese research and development expenditures are increasing to match those of the United States. The Japanese now recognize that they cannot continue to simply license or purchase foreign technology for modest fees or do "reverse engineering." They are on the technological frontier or virtually so in some areas, and Japan appears to be close to becoming a net seller of technology. New generations of technology are likely to be costly.

☐ The Japanese population is growing older. Because Japanese salaries and wages are linked to seniority, this translates into higher labor costs. Government social security payments are already beginning to increase, and this has the double effect of pushing up the tax burden and reducing the importance of the welfare function of private corporations. Eventually, layoffs—even if disguised with incentives for early retirement—will become inevitable. Will company loyalty and the company union structure survive?

Industrial democracy in action. Top executives of private companies in Japan average salaries of about $100,000, or $50,000 a year after taxes. In the U.S., the average annual income of a chair of the board is over $400,000 and a president's is $350,000. Meanwhile, the average amount paid to newly employed male college graduates in Japan is just under $7,000 a year, reduced to $6,500 after taxes. The ratio of presidents' to employees' salaries in Japan is thus less than 8 to 1, down slightly from about 10 to 1 in 1963 and substantially lower than the comparable figure in the U.S. (Data: Japan Federation of Employer's Associations, from *The Wheel Extended*)



☐ Increasingly, Japanese women are *not* leaving their jobs upon marriage or the birth of their first children. Some Japanese women are now candidates for managerial positions because of their seniority. Meanwhile, the percentage of women entering higher education has doubled in the last ten years, and the proportion of female university graduates is climbing. Can the Japanese system cope with female executives? Eventually it will have to, for Japan cannot maintain its rate of growth without fully exploiting the skills and intelligence of 50 percent of its population. But Japan will lose a source of cheap labor as pressure for equal opportunity for women grows.

☐ Services rather than goods represent an increasing part of Japanese gross national product. Indeed, the service sector now accounts for close to 60 percent of Japan's GNP, up from 30 percent in 1950. The rapidly increasing age of the Japanese population and the growing number of retired persons will be responsible for a further increase in the service sector, with the result that productivity growth is likely to be slowed.

☐ The increasing technical complexity of many Japanese products may make impractical the common corporate policy of employing generalists who are rotated among various areas while receiving on-the-job or company-sponsored education. Corporations are likely to require more specialized entry-level people at all ranks, thereby undermining the seniority and decision-making systems.

☐ The internationalization of Japanese business is well underway. Direct Japanese foreign investment has increased from $4 billion in 1970 to some $40 billion today, an annual capital outflow that is between 10 and 15 percent of the world's total. Some 445,000 Japanese are now living overseas, mostly as employees of private corporations. Will today's high productivity be maintained as this flow diverts investment capital and skills from Japan? Can a Japanese corporation investing abroad recruit and hold competent local managers when it is well known that no foreign manager can aspire to a top position in the parent company?

☐ There is statistical evidence that the average age of production facilities in Japan and the United States has been converging. In 1978, the Japanese average stood at eight years, the United States at about nine and one-half years—a spread of only one and one-half years. In the early 1970s, the difference was four years. The reason, one suspects, is the increasing pressure for social investments—housing, sewers, water systems, roads, and pollution controls—at the expense of investment in direct production.

☐ Various indicators of social change in Japan—the incidence of crime, divorce, and drug use, for examples—although still very low by U.S. standards, are beginning to move up. This may herald some social disintegration that could translate into higher costs.

☐ According to many recent surveys, Japanese youth are not as committed to long work days, shortened or foregone vacations, and intensive corporate responsibility as their elders. Those born in the last half of the 1940s, at the end of World War II, are now entering middle management in significant numbers; they are the first generation of Japanese managers brought up in affluence, never really having known deprivation and poverty. Have they been sufficiently indoctrinated into the corporate culture to accept the notion that corporate welfare comes first and personal and family welfare second? There is some reason to be skeptical. There is much criticism in Japan of the younger generation on this score, but I cannot be certain whether this reflects a normal generation gap or has greater social significance.

☐ Japan's goal of catching up with its World War II victor, the United States, has been virtually achieved. To the extent that this objective fueled the country's national effort through the 1960s and 1970s, that incentive will now be lacking as the per capita level of material well-being nears that of the United States. One senses a tendency to let down, and there has been

much discussion in Japan to this effect.

☐ Japan is perhaps the one major power in history, with the possible exception of Germany, that has not developed military power commensurate with its economic power. As the international competition for raw materials increases and Japan feels its supply lines jeopardized, the nation may well decide to become more independent of the U.S. umbrella by developing its own military strength.

☐ The growing density of population, industry, and traffic in Japan is generating problems and increasing costs. Consider these figures: The population per square mile in Japan is twice that of Indonesia and 22 times that of the United States. The cost of choice urban office sites ranges from $1,500 to $3,000 per square foot in Tokyo. And the ratio of wholesale transactions per retail sale is 4 in Japan, 1.8 in the U.S. The high cost of land and pollution controls has been joined by inefficiencies in distribution as major incentives for industry to invest abroad.

Redefining the Freedom in Free Enterprise

Despite all of these problems and more, the consumer price index in Japan advanced only 2.1 percent in 1980 and 3.3 percent in 1981. The average interest rates on loans and discounts of all banks remains in the range of 7 to 8 percent. Unemployment is between 2 and 3 percent, and real gross national product rose by 5.4 percent in 1981.

How do the Japanese do it?

I have already suggested one answer: the effective, full involvement of the workforce—at least the male workers. Queried as to the best English work describing Japanese management, one Japanese executive told me, "Douglas McGregor's *The Human Side of Enterprise*—the only difference is that we believe it." This was, of course, a reference to the late Professor McGregor's Theory Y: the idea that commitment and creativity stem primarily from sources within each of us, and that management's chief responsibility is to provide conditions under which these attitudes are unconstrained.

Another reason for the success of Japanese industry is the extraordinary cooperation between labor and management and between government and business. Here are some of the devices by which government has supported Japanese business to create what some critics have termed "Japan, Inc." which purportedly engages in "unfair competition":

☐ The use of public funds to aid private corporations for training, founding new enterprises, and locating new jobs for surplus workers.

☐ Public support for research and development and the commercialization of promising new areas of technology. Current national priorities include engineering ceramics, super-function polymers, new metallic and composite materials, biotechnology, new types of semiconductors, robots, optical fibers, alternative energy sources, fifth-generation computers, genetic technology to create self-fertilizing crops, and microbiology.

☐ A series of incentives, including a robot-leasing company, to encourage investment in automatic machinery. By mid-1981, Japan was producing three times as many industrial robots as the United States, and 57,000 units were in use in Japanese factories.

☐ The use of public funds for loans from private banks to stimulate investment by private business.

☐ A plan to permit companies to set aside reserves from pretax earnings against which losses from overseas investments can be written off.

☐ Government sponsorship of two nationally owned, nonprofit associations to market Japanese technology abroad. The services of these enterprises are promoted through Japan's largest general trading companies.

☐ Exemption from Japanese taxation of 70 percent of a company's income from the export of technology or on property rights paid for in foreign currency.

In more than 80 recent interviews with Japanese executives and scholars, I heard not one word of real criticism of the Japanese government; there was simply no sense of the "we-or-they" relationship that is part of virtually every conversation with U.S. executives. The conflict relationships throughout American businesses that maintain economic and social distance—between producers and managers and among firms, unions, government, consumers, owners, and financial institutions—are virtually absent in Japan. The contrast is startling.

The principal lesson for the United States is that it can no longer tolerate the higher costs of its adversarial relationships. In the final analysis, achieving high national productivity may depend more on efficient, harmonious organization than on efficient technology. We are all in this international competition together, and the most socially efficient nations are very likely to be the winners.

Professor Richard D. Robinson is in charge of teaching in the field of international business and technology transfer at the Sloan School of Management at M.I.T. He has had extensive international experience in the Middle East as well as Japan.

The Spirit of Harmonious Competition

How a Japanese business leader looks at his job and his colleagues

by Akio Iizuka

At the end of World War II, the giant family trusts that had dominated Japanese industry were dissolved, and most of the older leaders of both industry and government were purged as well. The task of reconstruction was left to new business leaders, who had no time-honored conventions or traditions to guide them. This freedom was a liberating influence whose ultimate result was Japan's present business-oriented society.

College graduates were given no special training upon entering a firm. Instead, those showing natural ability in their everyday work rose slowly to positions of responsibility in the executive ranks. All new employees had equal opportunities for success, and this, I believe, was a major stimulus for Japan's postwar growth. This situation continues today: an overwhelming majority of Japanese company executives have reached their present positions after steady promotion within their own companies.

Japanese companies have expanded what are called "social training" programs in recent years, in which corporations themselves assume the responsibility for turning their employees into productive adult members of Japanese society. This training, which begins as soon as a new employee enters the company, is an opportunity open equally to all. New employees are taught correct etiquette and courtesies, table manners, the proper way to address customers, and other fundamentals. Such training continues for a long time and shapes the initial work experience of a great percentage of Japan's labor force.

In a very real sense, a Japanese company is an "employee community"—a single, tightly knit family; or, to borrow

the words of Jiro Ushio, chairman of Ushio, Inc., a leading electric equipment maker, an "employee syndicate." There is a very strong trend in Japan toward allowing employees to participate in every phase of management. This includes blue-collar workers, whose participation in quality-control activities involves autonomous control over job-site operations. Examples of the top-down management pattern in Japan are rare. Extensive maneuvering is often required to make sure that everyone's opinion is taken into consideration and that official decisions reflect the general consensus.

In this form of business organization, there are fewer cases than in the U.S. or Europe of highly independent managers prone to sacrifice the good of the company for their own selfish advantage. Since the company is a family-like organization, it is considered most important to maintain internal harmony and insure peace among all the group's members. Persons who feel that they are special—that they alone are gifted and all other employees are fools—will not find themselves at ease in the drivers' seats of Japanese companies, where a more communal atmosphere encourages all employees to laugh or cry together.

Embracing Contradiction

But peace and harmony alone do not always mean business success, so the need to recognize the talents and achievements of specific individuals is also recognized. While harmony gives a company a solid foundation, individual strengths and skills enable it to grow.

It is obvious that with persons of the same educational

(Continued on next page)

"What we are hunting is burning dedication."

(Continued from page 53)
background entering a company at the same time, fierce competition between colleagues will result—and this competition is one of the mainstays of modern business in Japan. There is strength in the fact that all employees are given an equal opportunity in the beginning. The important point is that to be genuinely competitive in a Japanese company, one must balance individual capabilities with a spirit of organizational cooperation.

It may seem contradictory to say this, but Japanese managers typically possess both the ability to maintain harmonious relationships with their fellow employees and strongly individualistic leadership qualities. I call this combination a spirit of "harmonious competition." One of its corollaries is that, in the absence of the sharply defined structure characteristic of Western corporations, a Japanese manager must embrace this contradiction and still function in an efficient and capable manner. This requires, I feel, far more skill than that demanded from Western managers. In the West, a manager is judged only by the abilities he or she displays, but in Japan it is critical for a manager to maintain good relations with superiors and at the same time to train and develop subordinates.

The late Tsunao Nomura, first president of Nomura Securities, Japan's largest securities firm, once offered the following comment on this subject: "The Japanese salaried worker draws his energy from competition with colleagues. But even if he suffers setbacks or feels jealousy, the law of the jungle does not hold—he isn't allowed to strike out openly at a rival. He must get along well with his colleagues while striving to gain ground one step at a time. Naturally, there are shortcomings to this approach, and these shortcomings could very well be the downfall of Japanese companies in the future. But it seems reasonably certain that this situation will continue in Japan for some time."

Bottom Up and Top Down

This naturally results in a bottom-up management pattern, but at the same time the men who run major Japanese companies have adopted to a certain extent the Western style of top-down management: in the end they themselves must make proposals and plans and then give the orders that will see these measures put into effect. Thus, the view that Western company management is wholly top-down and Japanese management wholly bottom-up is simplistic; the mainstream approach in Japan is bottom-up, but the combination of the two is now recognized as essential.

Of particular interest and concern in the near future is the rapid internationalization of Japanese industry. It is said that large Japanese companies will soon be devoting equal amounts of their operations to the domestic market, exports, and overseas production. This will result in a mutual exchange of Japanese and Western management methods, and in the end the only methods that remain will be those that lend themselves to universal application. This means that the conventional bottom-up approach will no longer spell instant success in Japan. How the dual bottom-up/top-down approach of the most successful Japanese firms evolves in the future will spell the difference between success and failure.

Enter a New Generation

If Japanese management can be said to have unique characteristics, they depend on the diligence of Japanese workers, a trait shared by both blue-collar and white-collar workers. Closely related to this is the management mentality that all workers exhibit, with each individual striving to control and improve the quality of the work process and its products at each particular job site. What remains to be seen is just how much Japanese companies will be able to retain and enhance this positive factor in the future.

It is all too likely that Japan will go the way of other developed nations, so that as values become more diverse, it will no longer be feasible to rely on employees' diligence and will to work if a company expects to prosper. The employees who adapt most easily to present forms of corporate organization are those born before about 1940—in other words, those who are over 40 years of age. Individuals in this generation tend to apply themselves to their work spontaneously, even without special training. Younger workers, however, are different: it will not be possible in the future to expect workers to follow blindly the orders that come down from the peaks of the nation's vertically structured society. I feel, therefore, that the most vital challenge faced by Japanese business leaders today is how to refine (or instill) traditional Japanese virtues in these younger workers.

The Motivation Is Dedication

The average salary earned by the president of a Japanese firm is about $100,000 before taxes. The lowest-paid blue-collar workers average just over $6,000 a year after taxes. Thus, the difference in annual income between company presidents and newly employed workers in Japan has shrunk from the 100 to 1 ratio of pre-World-War-II days to no more than 8 to 1 today. Although the responsibilities of a company president are extremely demanding, few earn over $15,000 per month.

This means that the motivation to become a company president in Japan is very complex: there may be a chance to contribute significantly to the prosperity of the firm as a whole, but there is little chance of attaining truly great individual wealth. I once interviewed well over 100 business leaders on this question, and all expressed one common desire: to accomplish something of social significance, to make a substantial contribution to society at large. Even though their goals and respsonsibilities were vague, these men were all enthusiastic and diligent workers whose principal aim seemed to be a strong feeling of accomplishment. The goals themselves seemed less important than the satisfaction inherent in achieving them.

The conscious goals of Japan's top executives center on organizing people and achieving worthwhile objectives, both for themselves and their subordinates. The late Shinzo Oya, former chairman of Teijin, Ltd., Japan's largest polyester maker, once stated this philosophy metaphorically: "We business leaders are hunters of a sort, and what we are hunting is burning dedication." □

Akio Iizuka is editor of the widely read Japanese monthly Sentaku *(*Choice*). This essay is condensed with permission from* The Wheel Extended, *a Toyota quarterly review (vol. 11, no. 4, 1981).*

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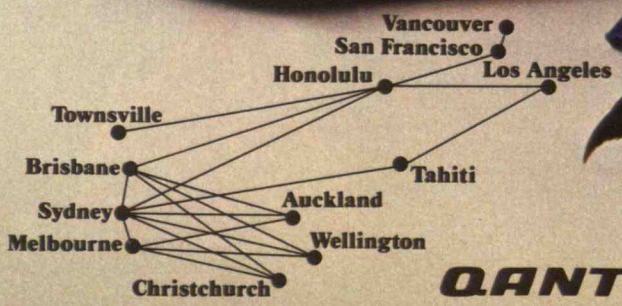

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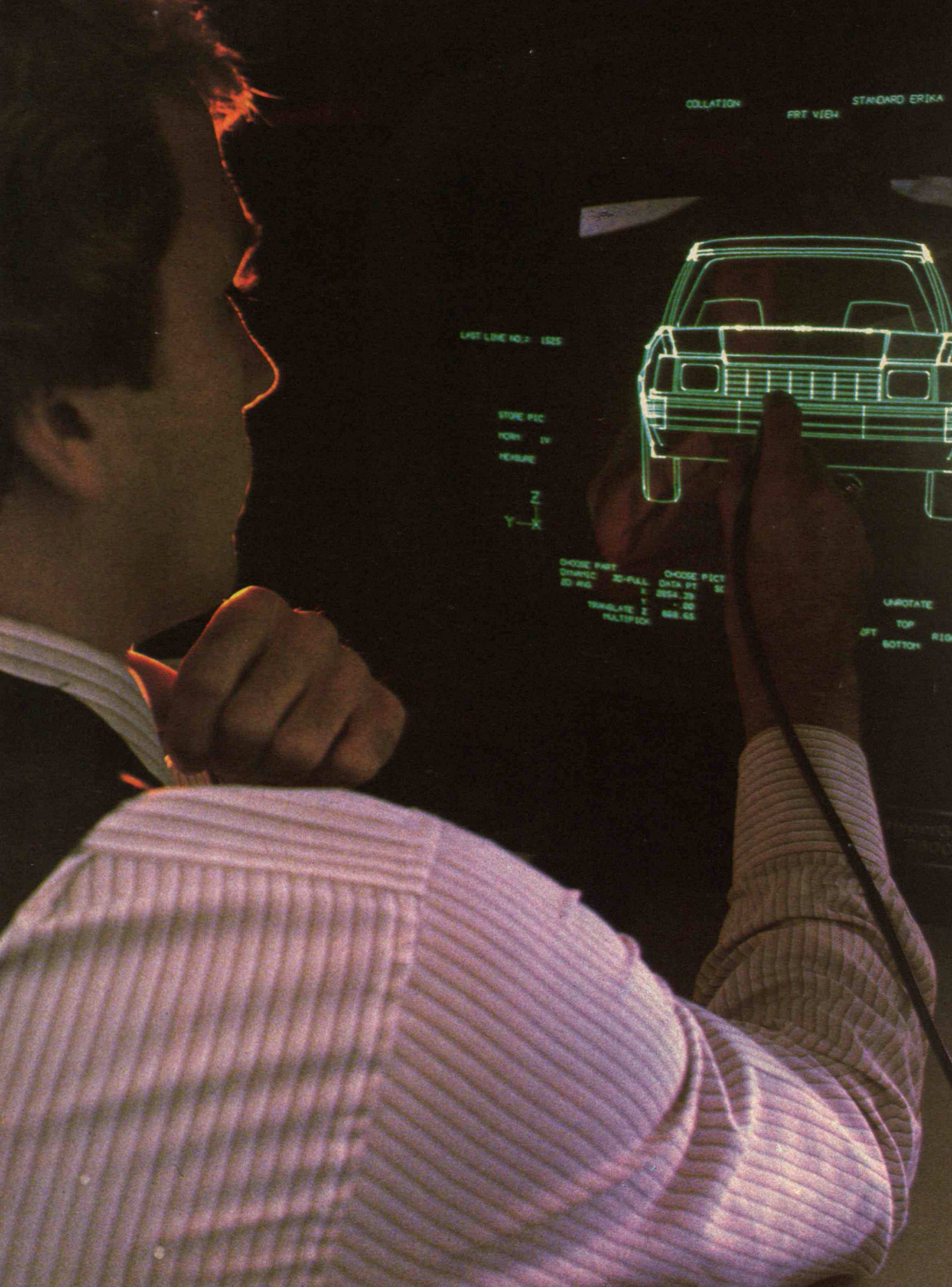
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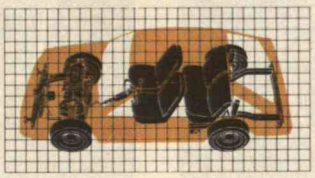
The U.S. automobile industry is completing a product conversion of unprecedented scope and cost. Now it must restructure its labor-management relations and turn international competitors into allies.



Shake-Out in Detroit: New Technology, New Problems

by Martin Anderson

In 1960 almost 8 million motor vehicles were built in the United States—48 percent of world production. Six million were produced in Europe, roughly 36 percent of world production, while Japan produced no more than 500,000 cars and trucks, only about 3 percent. Imports represented about 6 percent of U.S. sales and were largely balanced by exports of 4 percent of U.S. production.

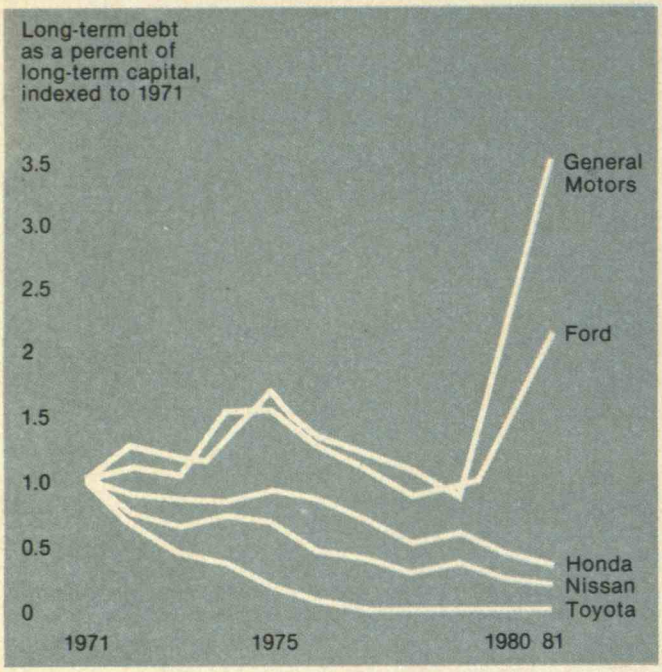
By 1980 the United States had in one way returned to 1960: production was only 8 million vehicles, the smallest number in 20 years. But the important landmark was this: that year Japan achieved supremacy in world production by building more than 11 million cars and trucks. It was the first time any nation had outproduced the United States since 1903, when 13,000 vehicles were built in France and only 11,200 in the U.S.

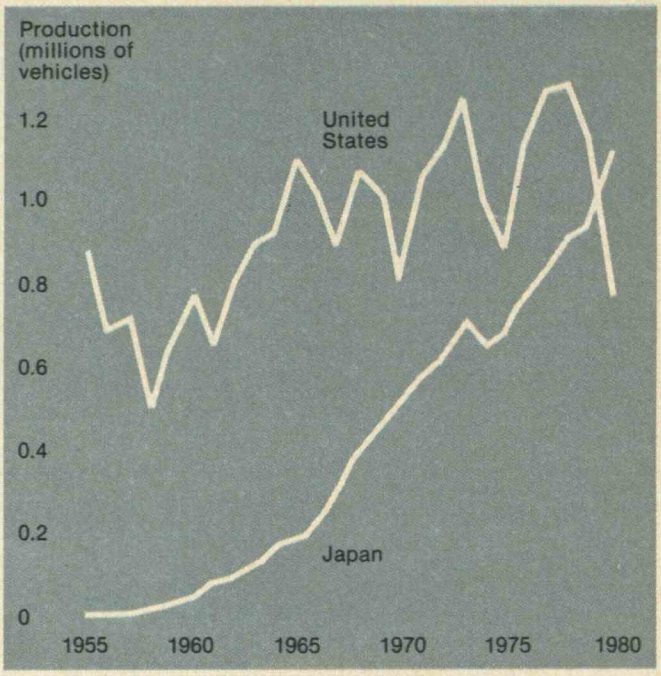
In 1980, Japan's share of world production rose to 28 percent while the U.S. share declined to 20 percent, and for the first time imported vehicles accounted for more than 25 percent of U.S. sales. U.S. automobile factories were running at only about half of capacity, and the industry lost more than $4.2 billion—an amount that may be a record for one concentrated industrial sector. Losses continued through 1981 and into the first months of 1982—a severe and prolonged industrywide recession.

Cars designed by computers. More than 1 trillion computations were made by Ford engineers in developing the new Escort-Lynx "platform"—all "long before the first prototype car was built," according to Louis R. Ross, Ford's executive vice-president for car development. Computer-operated design consoles such as this are among the new technologies in which the industry has made record capital investments during the past half-decade. (Photo: *Du Pont Context*)

New levels of corporate debt. The effort to "downsize" has forced U.S. automakers into unprecedented borrowing at a time when Japanese counterparts have been able to sharply reduce indebtedness. The result is that Japanese producers now hold more financial power and flexibility than any other segment of the world auto industry. Accordingly, they can invest in new products and plants at a lower capital cost than their competitors.

How the Japanese conquered the world. In 1980 the U.S. lost its 75-year leadership as the world's largest producer of automobiles. Japan's record from 1955 to 1980 may represent the highest-volume growth of such a "manufacturing-intense" capital-goods sector in industrial history. The Japanese now satisfy one-fourth of world automobile demand from an area less than three times the size of the state of Michigan.





The financial impact of reduced sales was compounded by the industry's unprecedented investments in capital equipment and tooling for new products—$11.2 billion in 1980 and $12.3 billion in 1981, more than double any previous peaks of annual spending. The sudden change in the sales environment in the late 1970s had rendered obsolete most of the industry's production assets, and every U.S. automobile company was scrambling to produce the smaller vehicles that government and consumers mandated. Historical investment criteria simply no longer applied; the goal was survival at whatever cost.

Three hundred auto-company plants in North America required gutting and refitting, changes that are both expensive and complex. For example, converting a facility to produce a new engine or transmission costs from $150 million to $500 million. Simply manufacturing a different component may cost $1 million; changing a complex suspension or driveline system will range upward from $200 million. General Motors' investment in the front-wheel drive for its "X-cars" in 1977 alone exceeded the combined capital spending of several major steel and technology firms that year.

A $1 Million Hourly Hemorrhage

The auto industry's effort to convert its obsolete assets began in the mid-1970s, after the first oil shock revealed the vulnerability of product lines. Originally, an $80 billion conversion of all North American production assets was to have taken place between 1977 and 1984. This investment in new technology, which would have cost more than the Apollo program and been completed in almost half the time, was designed to shift production completely to smaller cars and trucks by the middle of the current decade. The first stage of this effort to change product lines was so costly that U.S. companies' operating cash flows actually turned negative in 1978 despite record sales of vehicles worldwide.

When the market for larger cars collapsed and other countries rapidly increased their share of U.S. automobile sales in 1979 and 1980, American companies had to accelerate their capital spending programs. This brought about the $11.2 billion 1980 investment—equivalent to producing an Alaskan pipeline or a space shuttle in one year. That same year U.S. automakers' cash income from operations, normally the source of funding for new manufacturing plants, fell precipitously, leaving a deficit of $8.5 billion, a cash hemorrhage of nearly $1 million per hour 24 hours a day during the entire year. The balance was only slightly better in 1981, and the two-year deficit exceeded $15 billion.

Part of this deficit was met with $8.8 billion of

The profound changes made by the automobile industry may be the largest nonwar shift in technological, human, and capital resources in U.S. history.

borrowed money, which increased annual interest charges to more than $2 billion, or almost $200 per vehicle produced in 1982. In addition, expenses were reduced by laying off more than 40,000 management and 250,000 union workers and closing more than a dozen plant complexes. And some of the deficit ended up as red ink on the financial statements, representing a reduction in corporate value.

The profound changes made by the automobile industry between 1976 and 1982 may be the largest nonwar shift in technological, human, and capital resources in U.S. industrial history. But the job is by no means complete. In addition to changing its hardware and rebuilding its finances, the U.S. auto industry must restructure the 2-million-worker labor force in its factories and those of its suppliers, eliminating many jobs while making basic changes in labor-management relations. The changes of the past five years have brought U.S. auto companies close to their practical borrowing limits—and close, too, to their capacity to revolutionize technology and the workforce simultaneously. Unless profits can resume their traditional role as the source of new capital, and labor and management can find new cooperative relationships, U.S. companies will have to defer or radically alter the programs for product change planned for the rest of this decade. Indeed, it is not clear that new technology and investments—traditional American solutions to industrial obsolescence—can be used to resolve the broad problems of the automobile industry. There must also be changes in human, industrial, and government relations.

U.S. auto companies now have only three options for survival. One is to reduce the number of future product lines, which means accepting a smaller market share and, in effect, reducing the size of U.S. auto companies. Another alternative is to farm out portions of planned new-product lines for manufacture by suppliers, transferring some of the demand for new capital from the auto companies to their suppliers. A third is to make use of foreign capital and reduce costs by moving production to subsidiaries in other countries or by affiliating with foreign companies. All three of these strategies will probably be used during the rest of this decade.

The American companies that face this challenge are anachronisms: they are the largest single-product companies in the world. U.S. vehicle makers have never chosen (or been allowed) to diversify into major nonvehicle markets. The result is that demand for major revisions in automotive products represented a demand for this industry to change itself completely. There were no secondary products on which to depend for short-term profits and sources of new capital. As a result, broad questions of social and industrial policy are now at issue.

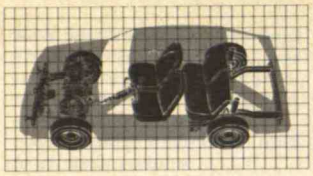
Must the U.S. government take a more aggressive role to protect domestic industry from overseas competition or to actively insure its revitalization? Can the United States continue to rely on huge undiversified manufacturing enterprises, supporting a vast network of suppliers, as a central element in the American economy? What service or high-technology industries could replace such a large, labor-intensive, geographically concentrated manufacturing sector? These questions make clear the profound national implications of the automobile industry's malaise and the success of its efforts to extricate itself.

Products as Platforms

The U.S. automobile industry grew to prominence by satisfying customers' demands in an environment where fuel was plentiful and its cost controlled and subsidized. When that environment changed briefly in 1973 and more significantly in 1979, U.S. automakers were confronted with rapidly changing customer demands for smaller, fuel-efficent vehicles that had previously been unsuccessful in the American market.

But foreign automakers—operating in environments with different energy policies, geographies, and demographics—had had at least 40 years' experience building the kind of vehicles Americans suddenly wanted. In a sense, the U.S. market joined that of the rest of the world: the major products of Japan, France, and West Germany were suddenly able to meet many demands of the American market. Yet that market was far from monolithic: when plentiful fuel returned in the mid-1970s and again in 1981 and 1982, many consumers turned quickly back to larger cars, leaving producers with underutilized small-car capacity.

That capacity is costly, and once in place it is very difficult to change. A typical vehicle contains more than 10,000 parts, all of which must meet high standards of quality, uniformity, price, and delivery. Creating a new vehicle generally takes five years from concept to production: two years for design and prototype testing and three years to acquire tooling and train labor forces. This process, though inaugurated by the automobile company, involves an intricate net-

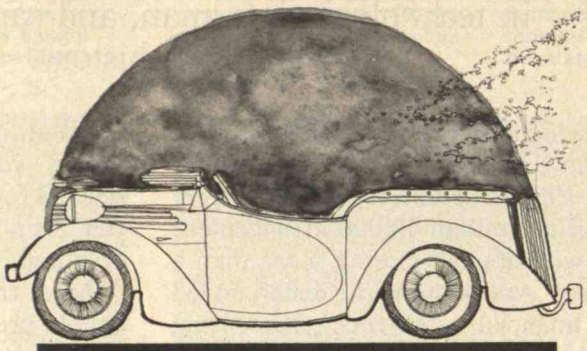


Downsizing Before Its Time

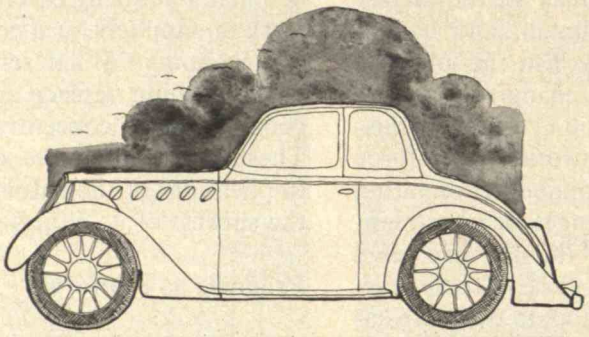
Why were auto companies making many big cars in 1979 when Americans suddenly wanted small ones? Because the companies would not have survived the 1970s had they attempted to make only small cars. Most small-car platforms made in the U.S. between 1930 and 1978 were "underachievers"—able to gain only limited sales in a market dominated by the large cars consumers clearly preferred in an era of low-priced energy.

PHOTOS: BETTMANN ARCHIVE

DRAWINGS: ED PORZIO



1938 American Bantam



1936 Willys

1939 Crossley

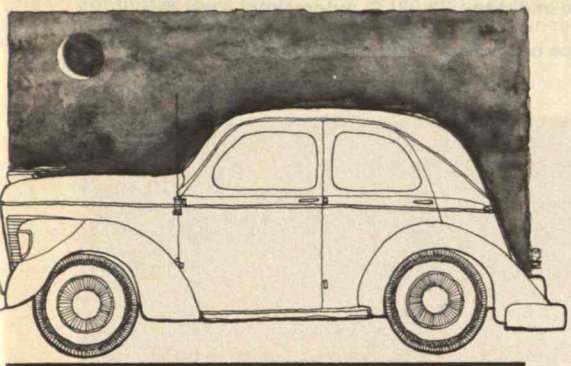
work of more than 30,000 supplier and service companies in many different locations. Organizing production in such a fragmented system consumes time, energy, and human effort. This five-year development cycle for a single new automobile line may cost as much as $4 billion, and with profits typical of the 1970s, a company must sell 8 million units to repay this capital investment.

This need to achieve such large volumes explains why new vehicles are designed as "platforms"—systems of components (such as engines, transmissions, and suspensions) that can be individualized through cosmetic sheet-metal and trim changes and sold under many different nameplates. For similar reasons, engines are designed as "modular" components, so a single engine design can be used for many years under a number of different nameplates and often in more than one platform. Thus, to be successful, platforms and engines must be used with only modest annual changes for 7 to 15 years, and short-lived, losing platforms can be disastrous. The industry's exposure during this decade of high capital investment—when the rate of introduction of major new platforms is three times higher than normal—is unprecedented.

Conceiving and designing a new platform involves three problems—market forecasting, production engineering, and human relations. Market forecasting has been a special dilemma in the last decade, for consumer demand has been more erratic than at any other period in the industry's history, changing far more quickly than new products could be created. One need only recall that at the end of 1978, American companies were rationing V-8 engines to keep their corporate average fuel economies above the government-mandated 19 miles per gallon, while Japanese importers held a 148-day inventory of unsold cars. Six months later V-8s couldn't be given away, Japanese cars couldn't be found in stock, and U.S. auto companies were discovering that even the most imaginative Madison Avenue advertising could not clear inventories of large cars if consumers wanted small ones. In that six-month period, 60 percent of U.S. carmakers' engine production assets became obsolete.

The most crucial automobile engineering problems today are in the field of production. Because automotive technology is advanced, it is comparatively easy to make new systems and devices that will perform in the laboratory and as prototype vehicles. But it is infinitely more difficult to build new systems into 10 million automobiles that will perform well in a wide range of environments and under the abusive conditions typical for vehicles in the United States.

Consider, for example, the complexity of manufac-



1938 Willys

1954 Nash Metropolitan

1954 Willys

1956 Nash Rambler

1951 Henry J.

1956 Hudson Hornet

turing an engine for American automobiles. More than 60 basic engine "lines" in the United States and overseas are used to produce power plants for U.S. cars, trucks, and buses. (A line is a tooling "package" for completely manufacturing one type of engine.) Each basic engine type may be manufactured to dozens of different specifications, each subtype being machined uniquely for the specific engine compartment of one final product.

A typical plant might produce 1,500 to 1,800 engines per day, or about 500,000 per year. Such a plant consumes about 100,000 tons of material annually, recycles 140 million gallons of water and oil, and requires more than 150 million cubic feet of air for ventilation and air compressors. Its equipment and tooling represent an investment of about $250 million, supplied by more than 30 different machine-tool makers here and abroad. Peripheral devices for pollution control, recycling, and testing represent an additional investment of $15 to $30 million.

The plant employs 2,000 to 2,500 people. Engine parts arrive from more than 100 suppliers, and engines are shipped to 10 to 15 assembly sites.

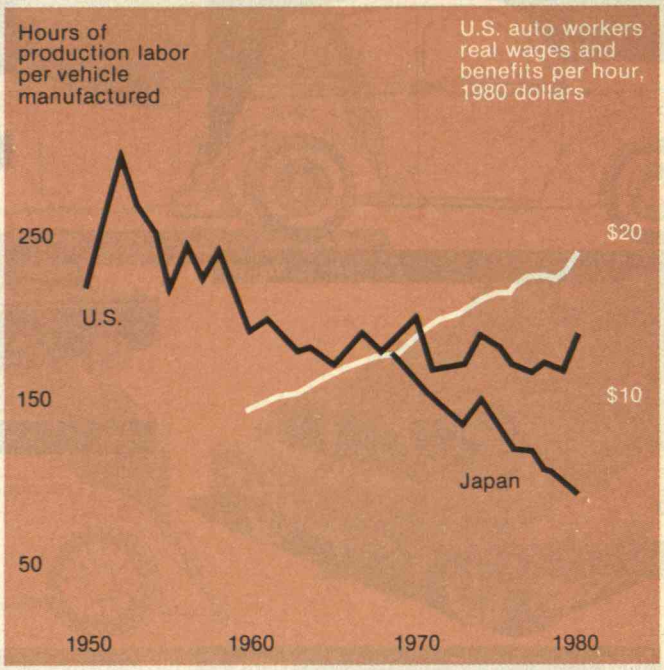
Such a plant is organized into departments, each of which is responsible for the cluster of operations required to produce one major engine part. A typical plant houses separate departments for machining and assembly of engine blocks, camshafts, pistons, crankshafts, cylinder-head, intake and exhaust manifolds, and oil and water pumps. Additional departments test engines and repair machine tools.

Each department in turn consists of from 5 to 100 stations, each of which performs one task. (One station, for example, may be responsible for drilling one hole; it is the smallest work unit in the plant.) Tools at each station typically range in cost from $10,000 to more than $100,000. The total cost for tooling in a department can exceed $30 million. And changes are expensive: a tooling change on one valve assembly might cost as much as $2 million by the time the engine plant and the plants of its suppliers are altered.

Extreme precision is required, and as "downsizing"—the move to smaller cars—dictates the use of smaller engine and drive-train components, precision becomes even more important. Automated machinery and even the factory floor must be aligned to tolerances within ten-thousandths of an inch.

Even with computer-directed machine tools, the equipment required for high-volume production is essentially inflexible: each machine makes only one part to tight specifications millions of times a year. The system is supple within specified tolerances but very arthritic if asked to change beyond those lim-

The battle for labor productivity. The labor content per vehicle manufactured in the U.S. has remained remarkably constant for the past 20 years, while Japanese automakers have improved their productivity dramatically since becoming a major factor in the U.S. market in 1970. The dotted line shows that the cost of U.S. labor to General Motors increased steadily between 1960 and 1980. Labor negotiations completed by U.S. automakers early this spring may mark a change in the slope of that line.



its—it is far less flexible than the marketplace was in the 1970s. To help solve the conflict between fixed tooling and volatile markets, manufacturers are changing product and process design. For example, new engines are being designed so high-volume parts can be interchanged, a strategy widely used in Japan to obtain economies of scale and market flexibility.

The Rush to Front-Wheel Drive

American automakers have followed three paths to improved fuel efficiency since 1975: they have downsized by making materials substitutions and other changes in existing platforms; they have developed new platforms based on front-wheel drive, which permits substantially reduced weight for a given interior volume; and they have moved toward smaller sizes, lower power, and better aerodynamics to reduce weight and increase efficiency. (*See "Automakers Lighten the Load" by Julius J. Harwood, July 1981, page 60.*)

The first wave of downsizing, begun in the mid-1970s and substantially completed by 1979, involved reducing the weight of conventional rear-drive automobiles by abandoning the largest platforms and adding luxury variants on the intermediate platforms, and by using substitute materials. As a result, luxury cars made in 1980 weighed at least 1,000 pounds less than those made in 1975, with comparable reductions in other full-size and intermediate platforms. The most effective materials substitution was the replacement of iron castings with aluminum. Other substitutions involved the use of polymers in place of metals.

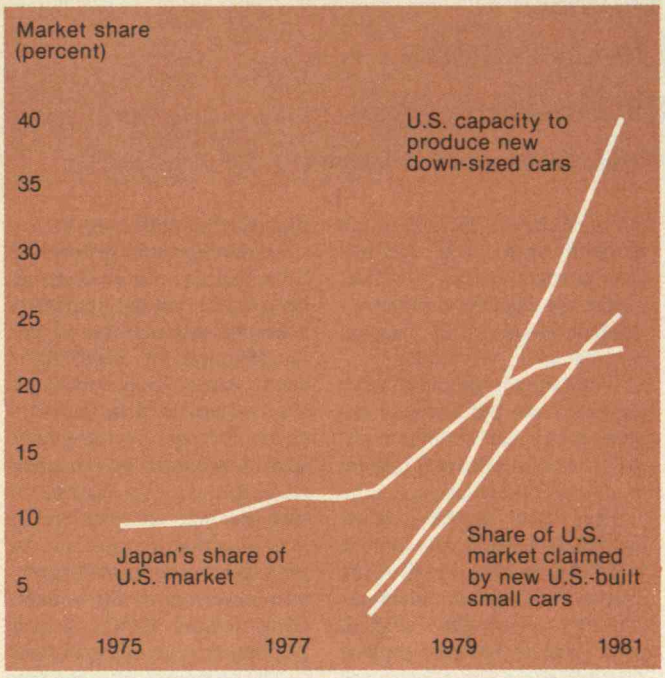
During the second wave of downsizing, new front-drive platforms were developed—vehicles with almost as much interior space as their predecessors but with dramatic advantages in vehicle size and weight. For American manufacturers, front-wheel drive represents a revolutionary reconfiguration of both product and plant, for these vehicles share essentially no parts with rear-wheel-drive predecessors. Axles, driveshafts, and transmissions are completely eliminated, replaced by axle-transmissions receiving power directly from transverse-mounted engines. In addition, completely new suspension and steering mechanics are required.

These changes affect countless suppliers as well as the automakers themselves, and the process of conversion to produce significant numbers of front-wheel-drive vehicles in less than five years has been a traumatic as well as prodigious achievement. The capacity to produce 3 million such units a year was in place by 1981, and capacity to produce up to 5 to 7 million more will come on line by 1986, depending upon the success of the earlier projects.

The third stage of downsizing is now upon us—the use of new technology to further decrease weight, reduce emissions, and increase efficiency. Engine controls are being changed from mechanical to electromechanical and electronic (*see "Microprocessors: Cars Now Have Minds as Well as Bodies," page 64*), and these systems also include sensors and circuits to optimize the entire driveline. Automatic transmissions have been redesigned with added gears and more efficient torque converters. Air-conditioning and power options are being scaled down to draw less energy from the engine, and bodies are being reshaped to provide more interior space and better aerodynamics.

U.S. automakers are now focusing on three clusters of motor vehicles on chassis with axles approximately 95, 100, and 105 inches apart, with luxury, standard, and economy vehicles in each category. Almost all these vehicles are now in direct competition with European-made and Japanese-made products. But there is still no American-made counterpart for the mini vehicles sent to this country from Europe and Japan—the Honda Civic, Renault Le Car, Toyota Tercel, and others—whose market share has doubled from 4 to 8 percent since 1975. At present, uncertain-

How the Japanese stayed on course. Even after U.S. automakers launched new downsized "platforms" from 1978 to 1981, and despite agreements to restrain exports, Japanese producers continued their rapid penetration of the U.S. automobile market. Weak demand for their new products—in which they had made unprecedented capital investments—forced U.S. automakers to hold production below capacity and even to close some capacity introduced since 1978.



ties in both consumer demand and the cost-efficiency of small car production have forced review of most plans for additional front-drive production in this country. The final decision depends on the marketplace and companies' ability to change the role and efficiency of the labor force.

There is essentially no U.S. market for the "micro-mini" vehicles, many of which are derivatives of motorcycles, long popular in Japan and elsewhere. If energy supplies become tight again, American consumers could quickly demand these very small vehicles, bringing more change to the American market and greater problems in production costs for American automakers. Micro-minis retail elsewhere for the equivalent of $2,000 to $4,000, and it would be almost impossible for high-cost U.S. auto plants to manufacture such cars for profitable sale at these prices. For this reason, American companies are preparing to import mini-cars from their Japanese affiliates if and when the market indicates their acceptability.

The Japanese Advantage

Most industry analysts agree that Japanese automakers can make a typical small car for at least $1,000 less than U.S. manufacturers, and some observers place this cost advantage at nearly $2,000. Furthermore, because manufacturing costs vary directly with vehicle complexity and luxury, and because the Japanese are especially efficient at adding options, their greatest advantage is in manufacturing the smaller but luxurious cars in which American producers have invested so much.

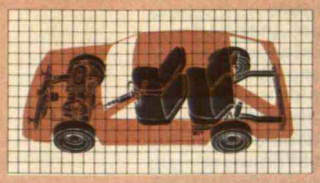
Given this advantage, the Japanese have two alternatives. If there are no import restrictions, they can capture a large share of the U.S. market by pricing beneath comparable American-built vehicles, or they can post competitive prices and realize higher profits on fewer units sold. Most Japanese producers have chosen the second course, and these profits are now being reinvested in new product lines and even more efficient production processes that promise stiff future competition for U.S. producers.

Some observers have suggested that Japan's auto industry should be a model for revitalization of the U.S. auto industry. It is true that Japan's auto producers have many organizational advantages that in principle could be duplicated in the United States. For example, Toyota and Nissan (which makes Datsuns), two of the world's strongest auto companies, are really only portions of much larger groups of related industries and suppliers. Their financing is broadly based, and the cost of their engineering staffs is spread across many products. Their labor relations are conducted for the entire spectrum of operations, and their relationship with the government is very different from that of the U.S. auto companies. Translating these advantages into the U.S. environment would require industrial and social changes of great magnitude. Because U.S. government policies are more constraining than those in Japan, Japanese companies may not be reasonable role models at all.

The Japanese production advantage is not, as some have said, the result of a miraculous advance in automation or of low-cost labor; it is the result of a complex set of management conditions and decisions combined with significant cooperation by both labor and government. Japanese tax systems have stimulated the capital investments required for expansion of the auto industry, and the government has supported export subsidies, market protection, and research on problems such as pollution-control devices.

Even before 1975, Japanese auto producers had begun serious efforts to remove excess material and energy from their products and production facilities. Toyota reports that in the past decade it has reduced the total energy required to produce its vehicles by 22 percent, and reduced petroleum content by 42 percent. Steelmakers say they have reduced petroleum

(Continued on page 66)



Microprocessors: Cars Now Have Minds as Well as Bodies

by Harry H. Lyon, James J. Gumbleton, and Stephen P. Stonestreet

THE idea that a computer could optimize fuel efficiency, emissions control, and engine performance in an automobile is not new. Indeed, the application is obvious: a computer can determine and make split-second corrections to operating conditions such as the air-fuel ratio, spark advance, and idle speeds, using data that no driver, however skillful, could manipulate. The surprising fact, even to automotive engineers, is how quickly computers have been applied to automobiles, pushed by the same pressures that have forced automakers to make unprecedented capital investments in every other field of automotive design and construction.

There were three major technological challenges to overcome in bringing microprocessors to these new tasks:

☐ Microprocessor technology had to be modified to meet the demands of the hostile automotive environment, which is characterized by wide temperature fluctuations, vibration, electronic interference from spark plugs and switches, humidity, dust, and corrosion.

☐ New sensing and actuating devices had to be developed so the computer could be constantly informed about critical operating conditions in the engine.

☐ Computer programs had to be worked out so the computer could generate proper changes in engine conditions in response to this information.

☐ Control links and actuators had to be devised so computer-directed changes could be made in carburetor, ignition, and other components.

For example, the proper timing of the spark depends on engine load, speed, temperature, and altitude. The problem is to monitor all these variables, program the computer to use this information to calculate the correct spark advance, and permit the computer to activate a spark-advance control to the proper value.

The first step in applying computers to engine performance was to determine the conditions to be controlled and the controls that could be implemented. The entire computer system was not devised at once. Rather, each area critical for achieving high fuel economy and low emissions, the two main areas of precision engine control to which microprocessors could uniquely contribute, was examined.

The most important aspect for control was the air-fuel ratio. The catalytic converter in the emissions-control system operates effectively only when the amount of air present is just enough to burn the fuel—when the mixture is said to be stoichiometric. Prior to 1981, when new emissions standards took effect, converters were engineered to work best when there was excess oxygen in the exhaust gas to react with hydrocarbons and carbon monoxide. This condition was met by running the carburetor somewhat on the lean side, or by adding more air into the exhaust system with an air pump. But the new limit of one gram of nitrogen oxides emitted per mile of travel presented the difficult problem of controlling nitrogen oxides as well as other combustion products—hydrocarbons and carbon monoxide.

The strategy was to remove oxygen from the nitrogen oxides so exhaust would contain only benign nitrogen instead of NO_x. To achieve this, the oxygen level in the exhaust gas had to be kept very low—a condition that exists when the engine is run either stoichiometrically or on the fuel-rich side. Indeed, studies showed that the engine must be run at the stoichiometric air-fuel ratio of between 14.6:1 and 14.8:1. There seemed to be no alternative to computer control to achieve this precise management.

In the computer system finally developed, a sensor mounted in the exhaust manifold functions as a small electrical cell, the voltage generated being dependent on the difference in oxygen concentration inside and outside the manifold. This voltage tells the computer how much oxygen is in the exhaust gas at any instant.

To provide a mechanism for computer control of the carburetor, the latter is provided with two fuel-scheduling positions, one leading to an air-fuel ratio of 13:1, the other 18:1. A solenoid controlled by the computer is cycled 10 times per second between "rich" and "lean" positions, with the air-fuel ratio determined by how long the solenoid valve remains in each position. The result is that the solenoid is able to constantly adjust the air-fuel ratio to very near stochiometric.

In practice this system has been further improved: it has been found that both performance and air-fuel control can be enhanced if information about engine load and speed are also provided to the computer. Information on engine speed is obtained by a magnetic pickup in the distributor that produces electrical pulses at a rate that depends on engine speed. Engine load is usually determined by sensors that measure either throttle position or manifold pressure.

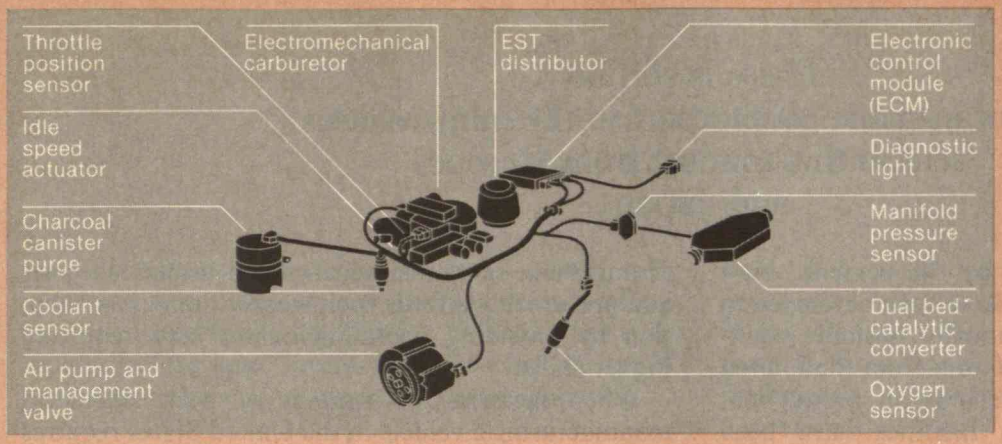
The computer can then free the air-fuel ratio from control at times of heavy load—such as when the vehicle is passing another vehicle on the highway under full throttle. This increases fuel consumption for a short period but assures full power when needed.

Because the air-fuel ratio to a cold engine may need to be fairly low—a "rich mixture"—the computer is also programmed not to bring the air-fuel ratio to stoichiometric until the engine has warmed.

Expanding the System

The air-fuel mixture is the most important parameter through which the computer can help achieve fuel economy and low emissions, and would alone justify the introduction of the microprocessor system. But the computer is also able to perform additional functions to improve fuel economy and driveability.

The electrical pulses from the distributor indicate the position of the pistons, and this, along with manifold pressure data, is the basis for con-



Microprocessor technology invades the engine compartment. Sensors on radiator, speedometer, distributor, catalytic converter, and exhaust manifold provide information on engine operating characteristics to the "black box"—the electronic control module (ECM). There computers use this information to control air-fuel ratio, idling speed, engine timing, torque converter clutch, and catalytic converter for maximum fuel economy and minimum emissions.

trol of spark timing. The computer can be programmed to fire each spark plug at exactly the right instant to give the proper balance between power production, emissions control, and fuel economy.

Idling speed is another variable now handled by the computer, which operates a small motor that changes the throttle idle position. The computer uses information from a coolant-temperature sensor to increase idling speed when the engine is cold or overheated. Under other conditions, the computer holds idling speed to a minimum for highest fuel economy, making adjustments as necessary—such as when the automatic drive control is moved from "drive" into "park" or "neutral."

Information on vehicle speed is provided to the computer by an electronic signal from the speedometer mechanism. (The beam from an infrared-light-emitting diode is interrupted by a speedometer-driven disc to provide a pulsed signal whose frequency is proportional to vehicle speed.) The computer uses this information to operate the direct-drive clutch on the torque converter in the automatic transmission, engaging or disengaging it as operating conditions dictate. The increased use of direct drive made possible by this system represents another example of the use of the computer to increase fuel economy.

Another computer function that reduces emissions and promotes fuel economy without sacrificing performance is control of the cannister-purge system. When any engine is turned off, a significant amount of gasoline vapor is likely to remain in the fuel tank and carburetor intake system. A cannister containing absorbent charcoal collects and stores these vapors so they do not escape but can be returned to the combustion mixture when the engine is next started up. The computer is programmed to flush the cannister gases into the carburetor only when the engine is warmed up and running at a certain minimum speed.

To control these functions, the computer continuously scans all sensors (one complete scan requires 100 milliseconds) and adjusts controlling devices to the proper settings. In addition, every 12.5 milliseconds this "main-loop" scan is interrupted by a "minor-loop" scan, which includes higher-priority operations, especially those controlling the air-fuel ratio.

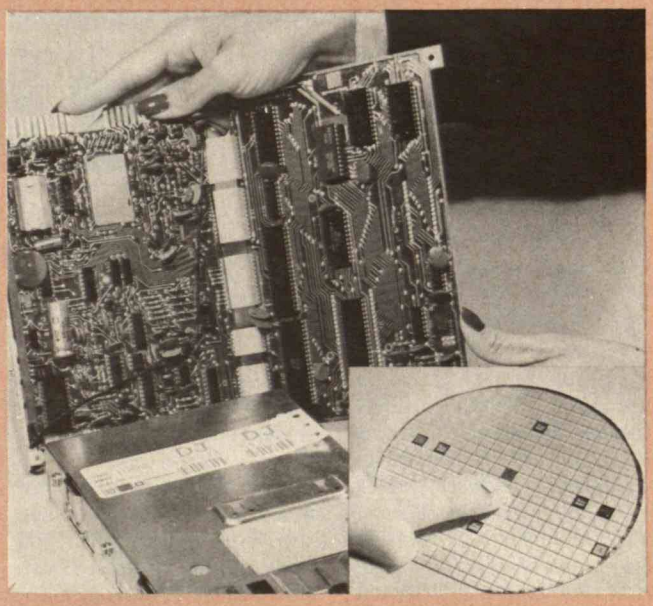
Imagination Is the Limit

The number of vehicle functions that can be controlled or monitored by the computer seems limited only by imagination and cost. In some systems the driver is provided with a dashboard indicator that can show some of the computer's information on engine operation and fuel economy. With inputs from the fuel gauge and odometer, the computer can calculate fuel supply in terms of mileage remaining.

Some owners may want to see even more information on the instrument panel—variables such as tire pressure, oil or coolant levels, battery conditions. Other functions could also be brought under microprocessor control: radio and other entertainment systems, theft-deterrent systems utilizing keyless ignition and door locks with electronic codes, automatic leveling, antilock braking systems that perhaps include radar-activated braking, and voice controls for unlocking or starting the car or carrying out other functions.

In 1980, the average cost of the extra equipment required to meet emissions standards on G.M. vehicles was at least $245. The final standards established in the Clean Air Act amendments of 1977 became effective in 1981, and higher corporate average fuel economy standards also went into effect. G.M.'s microprocessor-based system met these conflicting requirements while providing a smoother engine and enhanced performance. The average cost in 1981 was $725 per vehicle. □

Harry H. Lyon is chief engineer, James J. Gumbleton is manager of engineering, and Stephen P. Stonestreet is staff manager at the General Motors Proving Ground in Milford, Mich.



The "brain" of the computer-control system in General Motors cars. This electronic control module (ECM)—a "black box" slightly larger than a paperback book—contains a number of microcomputer chips (insert right). The ECM receives data from engine-mounted sensors, performs up to 350,000 calculations per second, and on the basis of these results, commands adjustments in air-fuel ratio, spark timing, idling speed, and other operating characteristics to improve fuel economy and performance and lower emissions.

There is still no
American-made counterpart to the mini-vehicles
sent to this country from Europe
and Japan.

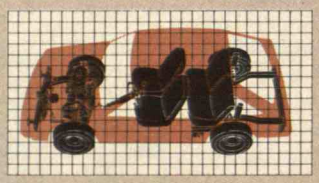
consumption in their plants by 50 percent. New sources of coal and aluminum have been developed to eliminate dependence on politically unstable countries, and scrap steel and aluminum from the United States is also used to save energy in production. Indeed, Japanese production facilities have been adapted several times during the last decade to changes in supplies of energy and raw materials, and this adaptability is one of the Japanese industry's great strengths.

Japanese labor unions are organized by company, not by trade. It is commonly believed that this encourages Japanese workers to identify their fortunes with their employers rather than with a separate union and discourages destructive confrontation between union workers and employers.

The Japanese have designed manufacturing systems with special emphasis on the interaction between machinery and human skills, yielding efficient utilization of labor and capital. Workers have flexible job responsibilities that allow them to make vehicles, repair machines, and exert true quality control. This arrangement saves maintenance and inspection costs and presumably affords each worker greater satisfaction by providing operating control and requiring higher skills.

When factories are running at peak efficiency, manufacturing a vehicle in the United States requires more than 100 hours of labor, depending on the company and the luxury level of the car; this does *not* include the labor investment of suppliers. However, manufacturing a vehicle in Japan requires less than 100 hours, *including* suppliers. Even if Japanese wage and benefit rates become comparable with U.S. rates, the Japanese auto industry will retain a cost advantage because of the fewer hours of labor built into each vehicle.

Most Japanese automakers exert significant control over supplier companies, and this large-scale industrial integration yields both production efficiency and strategic power. "Just-in-time" systems between automakers and their suppliers provide continuous deliveries of small quantities—a few hours' worth—of parts and components. These deliveries offer signifi-



Automakers of the Future: Diversified and Decentralized

More than eight years ago, in her book Paradise Lost, *Emma Rothschild foresaw the decline of the American automobile industry. Her prediction, widely disbelieved at the time, has been fulfilled more quickly and fully than its author expected.* Wharton Magazine *recently sent a transportation specialist of a somewhat different persuasion, Robert Barnett, editor of* The Runner, *to interview her at M.I.T., where Ms. Rothschild is now associate professor of technology, society, and rhetoric. Here are some excerpts from that interview:*

Barnett: The American automobile industry has declined even more quickly than you predicted in *Paradise Lost*, and recently American automobile firms have committed an unprecedented amount of capital to building smaller cars. Do you think that the basic Fordist and Sloanist orientation of the industry has changed?

Rothschild: If I were to imagine a very different kind of American automobile industry, I would look for diversification not from large cars to small ones, or from complicated cars to simpler cars, but out of automobile production altogether.

One of the things the American automobile industry may do over the next 20 or 30 years is increase its position as a creative builder of public transportation systems. With all the industry's technological potential, and all its potential in social research as well, this could already have been done. I think the dramatic failure of the United States to improve its public transportation system in the 1970s in such a way as to seriously affect energy consumption must be attributed, in part, to the attitudes of the automobile industry.

Barnett: Nowadays there is certainly less promise of federal money for mass transit.

Rothschild: Yes, but I think that the experience of a number of European countries shows that public transporta-

The size and composition of the automobile industry in the United States is very much in doubt.

cant advantages: face-to-face contact between suppliers and assemblers, smaller investments in inventories, the opportunity to identify defective parts or designs before large inventories of useless materials have accumulated, and simpler materials handling.

Can the U.S. Respond?

If they are to remain major competitors, U.S. companies must not only complete the massive conversion of their North American assets; they must also orchestrate with labor a new production system to counter these Japanese advantages. "Business as usual," however improved, will be inadequate. Aside from instituting strong protectionist measures, there is no other way to avoid the loss of world market share to the newly dominant Japanese companies.

To deal effectively with the Japanese competition, the U.S. labor content per car will have to be reduced at least 20 percent. Some gains can come from new tooling of production lines, including robotics, to increase productivity. Some reduction of labor content will be a natural result of making smaller cars. But much of the gain will have to come from changes in the manufacturing system, including labor relations. A robot tended by too many workers can be as inefficient as a conventional nonautomated drill press; a threatened or poorly motivated plant workforce can slow the most advanced computerized tooling through absenteeism, poor maintenance practices, and inattention.

In comparison with Japanese and European automakers, the U.S. industry employs large numbers of "indirect" workers—production workers who help on the line without actually touching the product, performing, for example, tooling adjustments and quality-control inspections. These jobs should be reduced in number, perhaps even eliminated. Computer-aided production systems, including improved inventory and quality control, will help. Work rules are already being changed to permit assembly-line workers to maintain and adjust the machines they use.

Obviously, such manufacturing changes will greatly affect workers' lives, and their adoption will pro-

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tion systems can constitute a profitable commercial market—even an export market. In the case of France, both bus and subway systems have made a significant contribution to the national balance of payments in terms of both goods and services.

Barnett: Why are we ignoring a potentially profitable business?

Rothschild: I think there is tremendous inertia associated with any industry that has been as dominant in a national economy as the automobile industry in the United States. Certainly there has developed around that industry a convincing political lobby that is basically not a pro-mass-transit lobby. That's been a factor.

I myself feel that there is no conflict between a view of transportation that emphasizes private automobiles and a view that emphasizes public transport. Any kind of rational energy planning would want to mix the two in a better way than is now being done. One strategy could emphasize the use of very small cars along with expanded public transportation in the center of large cities. This is not my idea; it's a very old idea, and still a good one, as anyone who has the misfortune to spend a lot of time in Manhattan knows. This is perfectly compatible with expanded use of private automobiles in other parts of the country.

Barnett: Why haven't we seen the development of a simple urban car?

Rothschild: One of the problems with driving a very small, simple car in the United States is that such a car is not the best place to be in a collision with a very big, heavy car. A strategy with strong incentives toward the use of small cars in limited city areas, where speed is rigorously controlled and journeys are much smaller, and larger cars for longer trips outside the cities would help get around some of these serious problems of auto use. I think it is very important to look at these issues in terms of overall transportation systems.

But of course that kind of strategy implies planning. And that is a political choice, and not the political choice that seems to suit the United States. It also involves a lot of complex collaborations among city, state, and federal government agencies that are far from easy to achieve.

Barnett: What would a progressive federal policy be toward industries such as steel and autos, which are not likely to see much growth in the next decade?

Rothschild: I've come to be suspicious of the notion of declining industry, except in the broadest terms. Given the tremendous technological complexity of all American industries, virtually every sector within manufacturing is a collection of subsectors, some of which are doing very well and others of which are doing very badly, and any successful policy must take account of this diversity.

Let me give you a tiny example. As a consequence of changes in the design of automobiles, many more parts are glued together now than were 20 years ago. As a result of health regulations, certain kinds of toxic glues are now barred, and there has been a great expansion in the industry that supplies water-based glues. It is an example of the

(Continued on p. 86)

Condensed with permission from "Running on Empty: The Problems of Productivity" by Robert Barnett, The Wharton Magazine, *vol. 6, no. 3,* © *1982 by The Wharton School of the University of Pennsylvania.*

Truly a "world car." Ford's European-made Escort is assembled in Britain, West Germany, and Portugal for sale throughout Europe and in many developing nations. Its parts come from countless suppliers in 17 different countries. (Chart: New England Economic Review from U.S. Department of Transportation)

Country	Components
Austria	Radiator and heater hoses, tires
Belgium	Hood trim, seat pads, tires, brake tubes
Canada	Glass, radio
Denmark	Fan belt
England	Steering wheel, oil pump, intake manifold, flywheel ring gear
England and France	Heater assembly
England, France and Italy	Cylinder head
England and Germany	Muffler and tailpipe assembly, fuel tank filler, steering column and lock assembly, heater, blower and control assemblies, speedometer cable assembly, turn signal switch assembly, wiper switch assembly, headlamp assembly, front turn signal, main wire assembly, battery, windshield, door and rear window, rear wheel spindles, front brakes, distributor, rocker arm, clutch
England and Italy	Windshield defroster, rear lamp assembly
France	Seat pads, sealers, underbody coating, weatherstrips, seat frames, heater, master cylinders, ventilation units, steering shaft and joints, front seat cushions, suspension bushings, hose clamps, alternators, clutch release bearing
France and Germany	Transmission case, clutch case
Germany	Cable assemblies, front wheel knuckle, pistons, cylinder head gasket.
Italy	Defroster nozzles and grills, lamps
Japan	Windshield washer pump, bearings, alternator, starter
Netherlands	Paints, hardware
Northern Ireland and Italy	Carburetor
Norway	Muffler flanges
Spain	Radiator and heater hoses, air cleaner, wiring harness, batteries, fork clutch release, mirrors
Switzerland	Speedometer gears, underbody coating
U.S.	Wheel nuts, EGR valves, hydraulic tappets

Entering the worlds of today's world car. German car buyers are exhorted to explore a newer universe, while Ford proclaims the international success of its newest "platform." Both these statements are evidence of how U.S. automakers are seeking worldwide markets to support current and future capital investments.

To reach full international cost parity, U.S. producers will have to resort to "outsourcing": shifting production to areas where labor costs are lower.

voke resistance. Labor negotiations this past spring, held six months earlier in the contract-renewal cycle than usual, addressed some of these issues. Both Ford and General Motors committed themselves to major investments in worker retraining and relocation and to partial subsidies for displaced workers.

In return for concessions on wage increases, U.S. companies agreed to maintain current "employment opportunities," an assurance sought by the unions to protect members against massive layoffs resulting from automation. Thus, because this provision is based on current depressed employment levels, the contract appears to offer the possibility of expanding production without adding workers—a gain in productivity—if sales increase. This would require changes in work rules that may be difficult to obtain, but a precedent has been established.

But the labor outcome is far from clear. A close vote on the contract at General Motors, where almost half the workforce rejected the pact, suggests that there is local resistance to the changes in work rules and job classifications necessary if automated tooling is to yield productivity advances. On the other hand, at a number of plants that could be closed because they are currently unprofitable, workers have made independent offers to local management to increase efficiency. The national autoworkers' union appears willing to allow greater flexibility at individual plants to solve local problems, a necessary step when so many plants are being converted differently. If these changes are accepted in many plants, the outlook for the industry will improve significantly.

But even if a 20 percent improvement in manufacturing efficiency is achieved in U.S. plants, U.S. automakers will retain a cost disadvantage because of the higher hourly cost of labor in the United States. American auto workers in 1981 earned an average of $20 per hour, including wages and benefits; suppliers' labor costs were 40 to 50 percent lower. Japanese auto companies report comparable rates of $10 to $12, including partial subsidies for lunches and dormitories, and Japanese suppliers also report lower costs. (It is significant that low-cost suppliers provide a much larger fraction of the total labor invested in a Japanese automobile than a U.S.-built one, where auto-company labor is the dominant factor.)

To reach full international cost parity, U.S. producers will have to resort to "outsourcing"—shifting the production of components to plants where labor costs are lower than in the United States. The most obvious locations are in the developing countries, where demand for automobiles is growing rapidly, labor is inexpensive (often one-sixth the cost of labor in the United States), large capital incentives in the form of subsidies for new facilities are often available, markets are likely to be protected from imports, and exports may be subsidized. These advantages represent an overwhelming incentive—almost a mandate—for U.S. companies to reduce costs by expanding their operations in developing nations.

But the economic trade-offs are complex. American auto companies can reduce labor costs by increasing their purchases of components from U.S. suppliers, who are not bound by high-cost auto-union contracts, and from Japanese companies. Indeed, U.S. automakers will soon be importing more than 2 million engines and transmissions annually from Japan. The dilemma of how to reduce costs without jeopardizing U.S. prosperity may well be resolved through compromise—with perhaps 30 percent of a car line's components imported from low-cost countries and the remaining 70 percent produced at U.S. plants. The total cost of the car might then be competitive, with over two-thirds of its labor content retained in the United States.

Although this hypothesized resolution may not materialize, three major trends are clear:

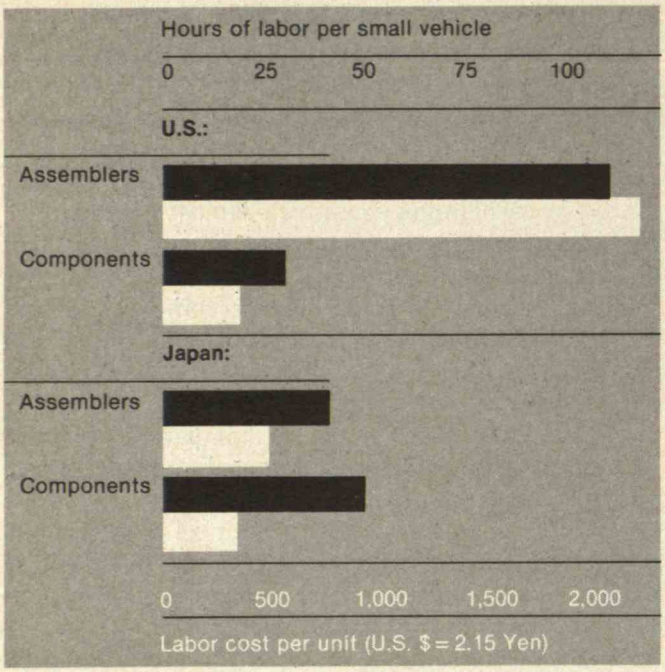
☐ The amount of labor used to build a U.S. car will lessen. Even if production returns to the levels of the 1970s, the ranks of labor and management will be substantially reduced.

☐ The location of production will shift; major U.S. auto plants will probably be recentralized around Detroit to reduce shipping and inventory costs. Smaller production units will be moved to the South or overseas to take advantage of lower labor costs, and suppliers will play a greater role in auto production.

☐ There will be no turning back on efforts to increase manufacturing productivity and change the emphasis of labor relations.

Reranking the Producers

The last five years have brought a new range of problems to management in the automotive industry. Market changes abruptly revealed the vulnerability of technologies and methods that were successful for decades, challenging the fundamental power of American auto companies. The industry is coming to grips with the task of telling plant managers they must reduce costs by 30 percent, fire many workers, increase product quality, install and use expensive,



The Japan-America difference. The amount of labor required per vehicle is strikingly higher in the U.S. than in Japan, a difference compounded by lower Japanese wages. Thus, the average labor cost differential is about $1,700 per vehicle. The Japanese also enjoy other cost advantages that offset the cost of shipping vehicles across the Pacific. Note that there is a disparity in wages at assemblers' and component suppliers' plants, and that more than half of the labor needed to make a Japanese car is performed in supplier companies.

untested new tooling, reduce parts inventories, and persuade suppliers to fill orders in hours instead of weeks.

Now the industry confronts the problem of unprecedented debts, including those from unfamiliar overseas capital markets. Financial reserves must be replenished by the middle of the decade to be ready for the 1990s, when market changes could once again require the industry to restructure its product lines.

But the broadest change being forced upon domestic management is the complete internationalization of automobile operations. Both manufacturing and marketing are now truly worldwide—similar components are produced in many locations throughout the world. For example, engines of one company can be built in several different countries and appear in many different vehicles, including those of other manufacturers.

U.S. managers who once had to think only in terms of the relatively stable domestic market must now respond to more rapid changes in demand at home while also seeking products to serve consumers in Asia, Africa, and South America—while producers in Japan, Korea, Mexico, and Brazil are suddenly competing for sales to farmers in Iowa. To meet this challenge, domestic management must learn much about world automotive needs, methods of international competition, and the roles and attitudes of foreign governments.

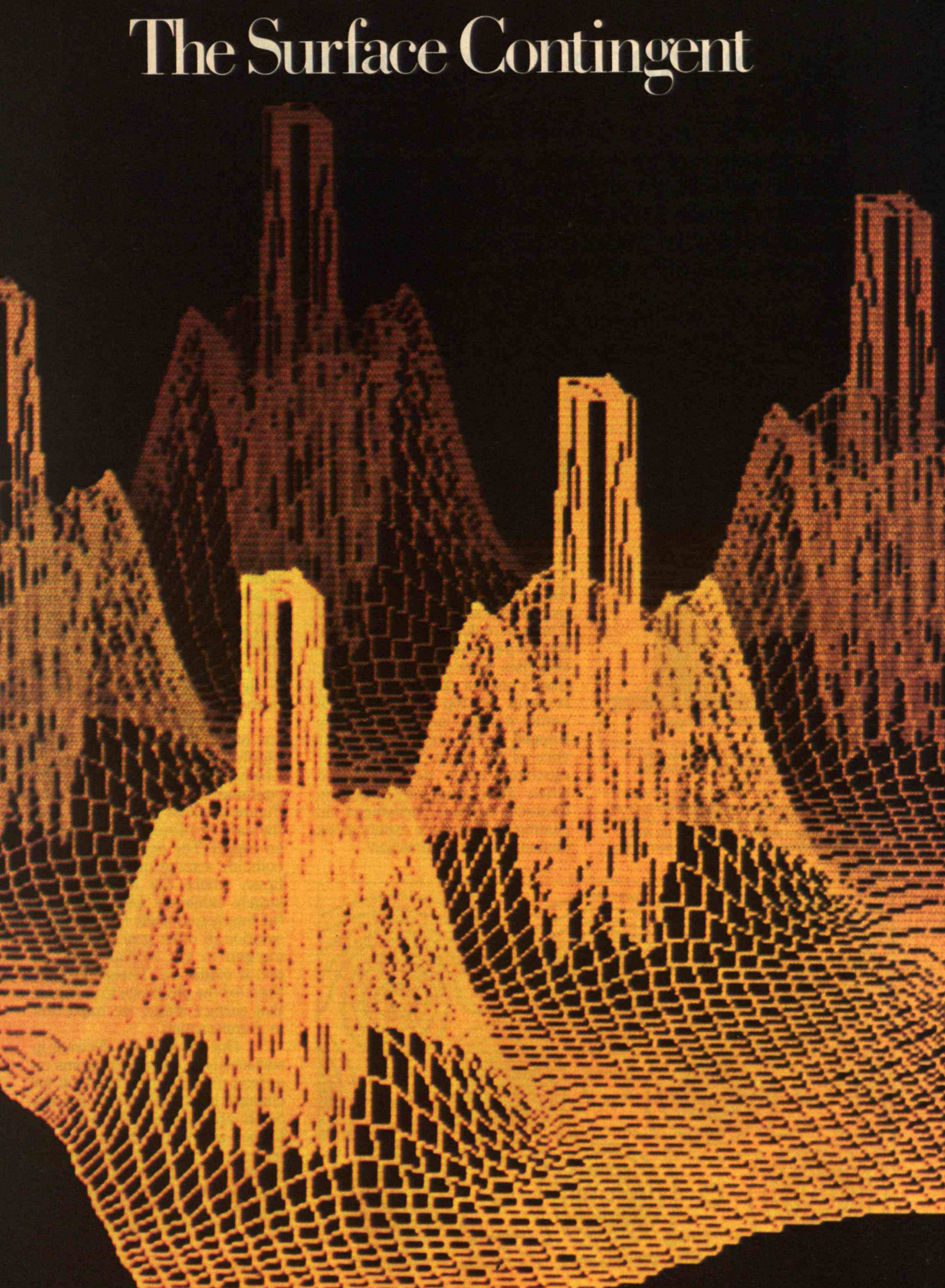
The broadening of the market from national to international has reranked the producers. Formerly dominant companies in Europe and the United States have lost some of their economies of scale, while rising companies—notably in Japan—have gained. But because capital investments in new products for the more homogeneous world market are so large, existing companies cannot fully capture scale economies; cooperation among producers is necesary. The developing relationship between General Motors and Toyota is an example of such cooperation. On the other hand, small specialty producers can capitalize on the continuing market for specialty products such as four-wheel-drive passenger cars. These opportunities will almost certainly lead to new alliances among companies of differing sizes and products.

The automobile industry will undoubtedly survive as a major world enterprise, and developed nations will retain the largest share of automotive technology and mass-production. But the size and composition of the automobile industry in the United States is very much in doubt.

Three years ago most observers thought that the U.S. auto industry simply needed to produce small cars to assure survival. We now know better: the small cars recently brought to market have not sold to expectations, nor have they yet earned a rate of profit adequate to repay the immense capital investments through which they were created. The rapid response of U.S. companies to current market demands suggests that the industry will continue to be a major factor in world production, but the ultimate outcome of this unprecedented industrial effort is still uncertain.

Martin Anderson, a consultant on automotive technology and the automobile industry, is executive officer of the international program on the future of the automobile now being coordinated at M.I.T. He was formerly associated with the Department of Transportation's systems research center in Cambridge, Mass.

The Surface Contingent



The Surface Contingent

A recent finding at the General Motors Research Laboratories has changed scientific thinking about the behavior of electrons in metal surfaces. This discovery provides a greater understanding of the fundamental physical processes involved in such surface events as adhesion, corrosion and catalysis.

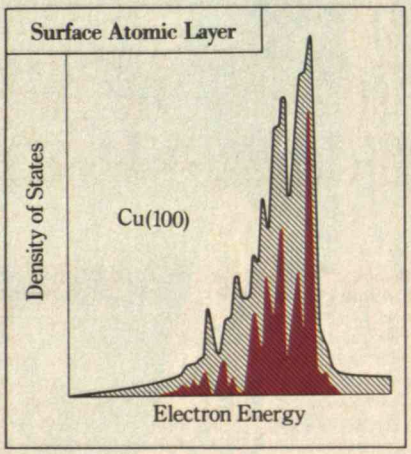


Figure 1: Energy distribution of electrons in outermost atomic layer. Red area indicates electrons in surface states.

Figure 2: Two electron density contour maps of the cross-section of a Cu(100) surface. One map shows a clean copper surface (tan); the other shows a nitrogen-covered copper surface (green).

CONVENTIONAL scientific thought treats virtually all of the valence electrons found in the surface atomic layer of a metal as if they are free to roam throughout the metal's interior. The work of three physicists at the General Motors Research Laboratories suggests otherwise. Through calculations confirmed by experimental data, the theorists have shown that more than a quarter of the valence electrons in the top atomic layer of some metals are effectively trapped in the surface. The presence of so many "surface state" electrons must be considered when analyzing physical and chemical surface phenomena, including such surface events as oxidation leading to corrosion.

Drs. John Smith, Jack Gay and Frank Arlinghaus applied their theoretical analysis to the (100) surface of five metals: copper, nickel, silver, rhodium and palladium. They made bold predictions concerning the percentage of electrons in the surface atomic layer to be found in surface states: Cu(36%), Ni(23%), Ag(23%), Rh(23%) and Pd(19%). The ratio of the red area to the hatched area of figure 1 gives the percentage for copper.

Electrons in surface states are not only abundant, but also highly localized on the surface. Chemisorption on a metal is also confined to the surface region. Figure 2 shows what happens in the case of nitrogen chemisorbed on copper. The two contour maps coincide except in the surface layer, where the interaction is largely exhibited. Localization of the interaction holds for the chemisorption of other gases, including oxygen in the initial stage of metal oxidation. These observations led the physicists to conclude that surface states are important in chemisorption.

One way to probe electrons in surfaces is to chemisorb atoms on a clean metal surface and look for changes in photoemission spectra. Such an experiment was performed at GM for fractional monolayers of nitrogen, oxygen and sulfur on Cu(100). The dominant change in the photoemission spectrum was the disappearance of a large peak whose shape and en-

ergy location was independent of the chemisorbed atom. It was of special interest that the shape and energy location of this peak was nearly identical to the envelope around the surface state peaks in figure 1. This suggests that surface state electrons play a major role in the chemisorption process.

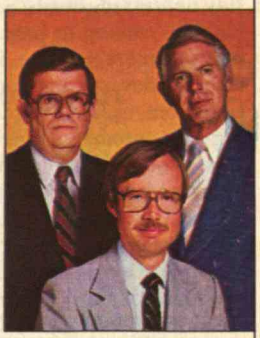
THE THEORETICAL advance at the heart of the discovery is the "Self-Consistent Local Orbital (SCLO) Method" for solving the Schrödinger equation. This new mathematical method was devised by the GM theorists to handle the classic dilemma posed by the self-consistency requirement. The characterization of electron behavior used to complete the equation must be consistent with the behavior predicted by the equation. In other words, one almost needs to know the answer in order to make the calculation.

Self-consistent solution of the equation for a metal surface is made exceedingly difficult by the three-dimensional nature of the electron density distribution. The theorists dealt with this challenge successfully by dividing the electron density distribution into two parts—the first part due to overlapping atomic density distributions; the second part equaling the difference between this atomic contribution and the exact density distribution.

One of the more stringent tests of the accuracy of the SCLO method was an angular photoemission experiment conducted by Heimann et al. at the University of Munich, subsequent to publication of the GM research. The German research team confirmed a prominent surface state band predicted by the three GM physicists. This was the first time a surface state band on a solid had been calculated prior to its being seen experimentally. The SCLO method makes possible something that could not be done before—accurate prediction of the actual behavior of electrons whirling around nuclei at the surface of a metal.

"The large body of surface states we found on metal surfaces," says Dr. Smith, "may be a controlling factor in many physical and chemical surface phenomena. By replacing conjecture with calculation, the new surface theoretical methods give us the means to make major steps forward in the analysis of surface and interface properties."

THE MEN BEHIND THE WORK



Drs. Smith, Gay and Arlinghaus are theorists in the Physics Department at the General Motors Research Laboratories.

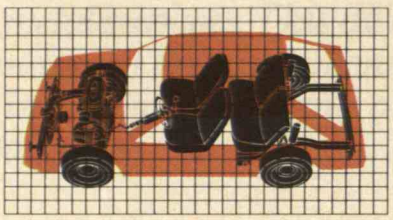
John Smith (center) and Jack Gay (right) received doctorates in physics; Smith from Ohio State University and Gay from the University of Florida. Frank Arlinghaus received his Ph.D. in physical chemistry from the Massachusetts Institute of Technology.

John Smith, leader of the GM solid state physics group, did postdoctoral work at the University of California in La Jolla. He joined General Motors in 1972. Frank Arlinghaus and Jack Gay joined the corporation in 1964 and 1965, respectively.

Each member of the team brings to the project a different expertise: Smith in surface physics, Gay in solid state theory, and Arlinghaus in bulk band structure calculations.

Trauma in Detroit

by Harley Shaiken



The human cost of keeping up with the Japanese is too seldom reckoned.

THE collapse of the market for domestic automobiles has left a devastating trail of social dislocation: hundreds of thousands of autoworkers thrown out of work, dozens of plants permanently closed, communities torn apart, and economies disrupted. Detroit, once a symbol of the nation's special industrial triumph, now has come to symbolize economic depression.

Even if the automobile market improves, however, industry employment will likely stay depressed. For U.S. automakers, seeking to hold a significant market share in the face of devastating competition from overseas, are rushing to automate operations and "outsource" components—trade jargon for subcontracting from both domestic and overseas suppliers. For example, Donald E. Petersen, president of Ford Motor Co., feels that Ford may be able to meet market demand in the coming decade using 125,000 production-related workers in the United States and Canada, slightly above current employment but about 35 percent below the number employed by the company in 1978.

The industry's present economic trauma is greater than any since the Great Depression. This trauma, combined with the industry's effort to redesign its products, have resulted in a wave of plant closings and layoffs. Employment has plunged from 1,005,000 in the peak year of 1978 to only 734,000 in 1981—down 27 percent in three years.

Chrysler, which operated 57 factories in the United States and Canada in 1979, now has only 38 plants open and plans to shut down an additional 6 plants by the end of 1983. Its Huber Avenue Foundry in Detroit, a mammoth white concrete building trimmed in Chrysler blue that was completed in 1966, is now shuttered, a victim of the industry's lowered volume and reduced need for cast iron. A sign informs passersby that 1,114,000 square feet on 43.5 acres of land are for sale or lease. While the grass in front of the plant is still cut, three-foot-high weeds and abandoned homes across the the street reflect the closing's impact on the city.

Ford has mothballed six plants and three distribution centers, and the fate of a number of others now hangs in the balance. Even General Motors has closed a number of plants and postponed some major investments, including a controversial new Cadillac plant in the Poletown section of Detroit.

But this is only the tip of the iceberg; suppliers have also been hard hit. Thousands of supplier industries, from mammoth steel mills to small tool-and-die shops, have been affected, and shock waves have reverberated throughout the U.S. economy. According to employment tables from the U.S. Department of Labor, for each auto worker laid off, 2.4 jobs are eliminated in the supplier networks and the community, including manufacturers of steel, tires and rubber products, and even fabrics and textiles. The Department of Transportation estimates that between 1979 and 1981, almost 100 supplier plants went down, idling over 80,000 workers. Some of these, now listed as excess capacity, may never be needed again.

Assembly Lines to Soup Lines

Unfortunately, the trauma has not been distributed evenly throughout the country. Some 80 percent of all motor-vehicle jobs are in five states, four of which—Illinois, Indiana, Ohio, and Michigan—now have 25 percent of the nation's unemployment. Michigan, dependent on automobiles for 55 percent of its manufacturing jobs in 1979, has experienced double-digit unemployment for over two years, with the rate still over 14 percent. And in 1980, over 250,000 people in that state exhausted all unemployment benefits. Indeed, conditions there have become so desperate that the state unemployment office has been compelled to furlough 22 percent of its 5,000-person staff since September 1981: workers assigned to find jobs for the unemployed are now themselves walking the streets.

Detroit is particularly hard hit because the troubled Chrysler Corp. is its largest employer. Chrysler's production-related employment in the area has plunged from over 50,000 in 1978 to 20,700 today, contributing to the 160,000 Detroit residents who are unemployed. One out of every three people in the city—some 400,000 individuals—now depend on some kind of public aid. The city once known for its assembly lines now has soup lines to feed the hungry. (Last year the Capuchin Fathers fed 18,000 families, compared with 6,000 in 1978.)

In Flint, Mich., its birthplace, General Motors' employment has slid to 60,000 from a 1978 peak of 78,000, propelling the unemployment rate to 23 percent, the highest for any major metropolitan area in the country. As recently as 1980, Flint's average annual pay of $18,704 was the second highest in the United States. Many of these highly paid industrial workers have found themselves without jobs virtually overnight—and with few alternatives.

Four Cars Imported Equal One Job Lost

The U.S. auto industry is now making major changes to reposition itself. *Business Week* reports that automkers have trimmed overhead costs by $9 billion and obtained $4 billion in wage concessions from the United Auto Workers, lowering their break-even point by 3 million cars. For example, Chrysler is now positioned to make a profit at a million fewer units than it could in 1979. Ford and General Motors are both aggressively pushing for changes in work rules that will lower labor requirements and increase flexibility.

The industry views this flexibility as critical for the efficient operation of the billions of dollars of highly automated equipment it is planning to install. Indeed, General Motors will purchase 20,000 robots in the next ten years. The company's experience is that each robot does the work of 1.7 workers in an assembly plant and 2.7 workers in a manufacturing plant, even after accounting for workers who install and maintain the robots. This means that robots alone could displace another 40,000 to 50,000 workers in the 1980s.

In another example, a Chevrolet engine assembly

line scheduled to open in Flint at the end of the summer is targeted to produce 250 engines an hour with half as many workers as required in the 1970s. By 1990, computer-aided design is expected to be used in 90 percent of Ford's design and drafting work, significantly reducing the number of jobs there.

U.S. automakers are also seeking to pare costs by moving manufacturing operations overseas and buying components from suppliers instead of making them themselves. While 5 percent or so of a U.S.-built vehicle is now manufactured abroad, this could double or even triple in the next five years. Moreover, General Motors announced in June that its new mini-car will be built in Japan through its affiliate, Isuzu. The company will import upwards of 200,000 of these cars a year into the U.S. beginning in 1984. This is in addition to projected plans for Suzuki to build 100,000 G.M. mini-cars annually. Should these cars prove successful, far more could be imported.

According to Phillip Caldwell, Ford's board chairman, every four vehicles imported into the United States results in the loss of one U.S. manufacturing job. This means that G.M.'s plans in this area alone could imperil 75,000 jobs, a cost undoubtedly not included in the investment decision. Caldwell says that each foreign car sold costs the U.S. government about $2500 in unemployment benefits and lost taxes from autoworkers, manufacturers, and suppliers.

Who Pays?

Many analysts argue that unless the industry takes these drastic steps, even more jobs will be lost. But what happens to workers who are displaced during the industry's effort to become more competitive?

To the extent that such social costs are ignored, they will fall directly on those least able to pay—the unemployed workers and their devastated communities.

We need innovative strategies and different forms of industrial change to mitigate these social costs. This is particularly important since slow economic growth and increased automation may limit job opportunities in other sectors of the economy.

One approach might be to link the introduction of robots and other new technologies to reduced work time for employees, thus translating part of the potentially spectacular increases in productivity into more jobs rather than higher unemployment. In addition, public funds are needed to retrain and relocate workers into new jobs. Another unexplored option is governmental aid to stimulate alternative uses for idle auto industry capacity, perhaps involving new community- or worker-owned enterprises.

Legislation may be the only alternative to stem the rush of U.S. automakers to move production to lower-wage areas of the world. Such legislation would mandate that a major portion of every automobile—say 90 percent for manufacturers producing in volume—sold in the U.S. be built domestically. While this requirement could result in somewhat higher prices, it would clearly be less costly than the social disruption accompanying the erosion of the industrial base. □

Harley Shaiken, a specialist in the effects of technology on labor, is a research associate in the M.I.T. Program in Science, Technology, and Society.

TRENDS

The Reaganomics of Toxic Chemicals

The Toxic Substances Control Act (TSCA) broke new ground when it became law six years ago, directing the Environmental Protection Agency to balance risks with benefits in managing hazardous chemicals. Though this risk-benefit analysis makes TSCA consistent with the Reagan administration's philosophy of regulation, the government's campaign against waste and overregulation is nevertheless bringing changes to the EPA's stewardship of TSCA.

As a result, the mixed reviews that TSCA earned from the chemical industry during its first five years are giving way to growing enthusiasm for the EPA's initiatives.

One TSCA effort that everyone applauds is the basic inventory—the list of 55,000 chemicals now being manufactured in the U.S. that EPA has assembled since 1977. "No similar document exists in any other country," E. Hamilton Hurst, vice-president for environmental health and safety of Nalco Chemical Co., told the American Chemical Society's 1982 spring meeting. The list is "a valuable tool" for both EPA and the industry, and many foreign nations are busy assembling similar data.

There is also industrial enthusiasm for EPA's changing philosophy concerning the TSCA requirement that chemical companies give "premanufacturing notice" (PMN) 90 days before they put new chemicals into production. EPA is to use that 90-day period to determine if the chemicals have risks greater than their potential benefits.

Douglas G. Bannerman, acting director of EPA's Office of Industry Assistance, told the ACS that over 1,000 PMNs have come to EPA since 1979, when the requirement took effect. The result, he said, "is the only complete and accurate record of the development and commercialization of new chemicals ever compiled . . . a wealth of information."

But C.W. Umland of Exxon Chemical Americas said the PMN requirement has caused "substantial disruption of new chemical development and introduction," and J.R. Yost of the Muskegon Chemical Co. called the PMN requirement "a unique burden for small companies," where most U.S. innovation is supposed to take place. Dr. Bannerman's analysis shows that just over 70 percent of the PMNs have come from large companies (with over $500 million in annual sales). And he admits that by adding costs and delays, TSCA may have caused "a significant reduction in new-product innovation among smaller specialty chemical firms."

Of more than 1,000 PMNs received, EPA has kept only 9 chemicals off the market. But Dr. Bannerman pointed out that TSCA's greater achievement has been to keep other new chemicals off the market by encouraging companies to take "a more responsible look" on their own.

This low rejection rate, coupled with the Reagan administration's initiatives for regulatory relief, have encouraged EPA to issue some exemptions: PMNs will no longer be required for three classes of new chemicals: high-molecular-weight polymers, chemicals that are intermediates to other products and used only within one manufacturing plant, and some very low-production specialty items. And Dr. Bannerman brought the ACS a special message from Washington: "Don't let the PMN requirements limit your creative spirit in the development and commercialization of new chemicals."

But J. Clarence Davies of the Conservation Foundation is not entirely comfortable with these initiatives. The long latency period of chronic effects from chemicals means that the pre-Reagan PMN system simply hasn't been proven; even if a dangerous chemical has slipped past EPA's sieve, we wouldn't know it yet.

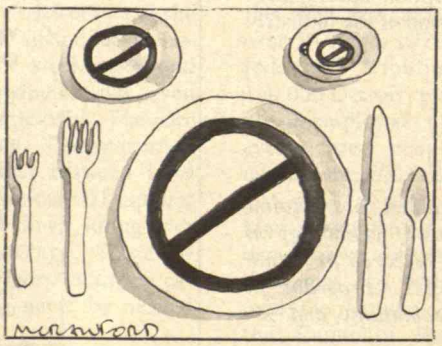
EPA's other job under TSCA is to study the 55,000 existing chemicals already in production for possible hazards—clearly a prodigious effort that is beyond any reasonable resources EPA might have had even during the Carter administration. That enterprise has now been largely abandoned as just too ambitious.

In doing that, Dr. Davies told the ACS, the EPA "surrendered what should be one of the main benefits of TSCA—the opportunity to comprehensively review the universe of commercial chemicals." But he lamented that this retrenchment might be necessary. "Under Reaganomics, asking EPA to look for new chemical problems is akin to complaining about the lack of good French restaurants in San Salvador. If survival is in question, some desirable goals must be sacrificed."—*J.M.* □

Regulating Food: Cancer on Your Plate?

U.S. food safety laws mandate "zero risk," in contrast to risk-benefit comparisons required by the Toxic Substances Control Act (*see above*). The Delaney Clause says that no food product can be sold in the United States if it contains a measurable quantity of any known carcinogen.

What is a "measurable quantity"? That depends on when you ask, and of whom, for methods of chemical analysis are constantly becoming better. Analysts are able to identify ever smaller quantities of pollutants in a food, down to parts per billion or even trillion.



It was a somewhat different world when Representative James J. Delaney first heard in 1950 the judgment of Dr. W.C. Heuper, chief of the Environmental Cancer Section of the National Institutes of Health: "I do not believe that one can establish a safe dose of carcinogens. . . . It would be a wise precautionary measure not to add any chemicals to our food supply that produce cancer either in man or in experimental animals." Thus, the Delaney Clause was born.

All this explains why major revisions in the Food Additive Amendments of 1958 to

the Food, Drug, and Cosmetic Act are now before Congress—and why members of the American Chemical Society devoted so much of their 1982 spring meeting to the issue.

The issue arises in part because of the increasing use of plastics in food packaging—and the fact that minute quantities of the polymers in the containers migrate to their contents. It's now possible to detect such migration, and so the offending containers are outlawed under present law. But Howard R. Roberts, former acting director of the Bureau of Foods in the Food and Drug Administration (FDA) who is now with the National Soft Drink Association, told the ACS that many of these constituents "occur at levels so minute as to be toxicologically insignificant."

He joined Michael R. Taylor, formerly a lawyer for the FDA, in appealing for a change. "The public health benefit derived from closely regulating such minute amounts of substances is frequently outweighed by the tremendous resources being expended—by government and industry—in chasing the elusive zero," said Mr. Taylor.

That search for the "elusive zero" can be expensive. William Horwitz, acting director of FDA's Science Policy Staff, described a new method for determining the dioxins in fish down to a level of about 50 parts per trillion—at a cost of about $1,000 per determination.

And then there's the problem of accuracy. Dr. Horwitz cited analyses of identical materials by different laboratories that varied by 55 percent at the 40-parts-per-billion level.

The problem of aflatoxins—the carcinogenic molds sometimes found on corn and peanuts—provides another example of the difficulties, expressed by one participant: "If you can see a carcinogen, it will hurt you; but if you can't see it, it won't."

When analytical chemists could detect aflatoxins at the level of 20 parts per billion in consumer products such as peanut butter, the FDA lowered the limit accordingly. But by now it's possible to detect 1 part per billion of aflatoxin in peanut butter, and enforcing that limit would in some years foreclose marketing as food nearly half of the nation's peanut butter, said Joseph V. Rodricks, vice-president of Clement Associates, Inc., who was associated with FDA for 13 years.

Accordingly, FDA has decided with some uneasiness to base its regulatory decision not only on analytical detectability but "on the technical capability of manufacturers to control the aflatoxin content of their products," said Dr. Roberts. The question of risk is not dealt with explicitly.

Two bills now in Congress would change all this. Senator Orrin Hatch would require food manufacturers to tell the FDA in advance what chemicals, and how much of them, would be in new food products, and they would be asked to provide appropriate toxicological data. Ninety days later the manufacturer would be free to market the product unless FDA had objected.

A different approach, sponsored by Representative Albert Gore, would permit food impurities in "*de minimus* amounts." Representative Gore doesn't define *de minimus*, but Mr. Taylor says the implication is clear: "*de minimus* refers to an amount of a substance that, taking into account what is known about [its] toxicity . . . poses risks that are so small or so improbable that they can reliably be said to be *de minimus*, or simply not worthy of government concern."

But the question of risk, absent in today's "technical-feasibility" criteria, opens the issue to personal rather than legal or scientific decisions. Judith Rae Brunton of the Washington law firm of Hyman and Phelps, specialists in food, drug, and cosmetic law, told the ACS that "there is no single acceptable risk level for all foods among all consumers." If the "technical-feasibility" criteria are abandoned, "one of the choices among the acceptable levels of risk—no risk—has been eliminated." In that case, she warned, the public will turn to the scientific community "to identify and quantify the risks that must be accepted." And so far, "Science hasn't been able to answer those questions."

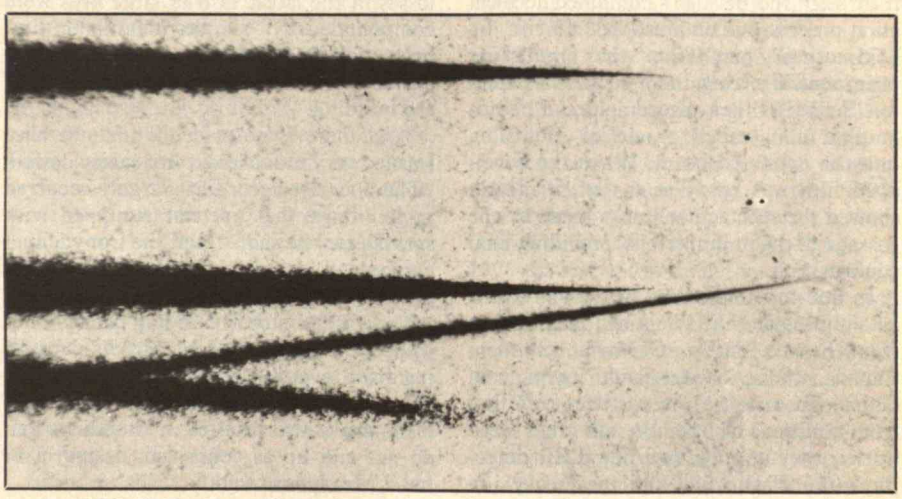
Ms. Brunton concluded that the present controversy is merely "the opening argument in what promises to be a long debate about fundamental social change."—*J.M.* □

World's Fastest Uranium

There was jubilation when final confirmation came at 6:00 P.M. Tuesday, May 11. A giant atom smasher at the University of California's Lawrence Berkeley Laboratory—the Bevalac—had become the world's first machine to accelerate uranium particles to nearly the speed of light.

Long a goal of nuclear scientists, this feat provides a vast new capability for exploring the fundamental properties of matter under the extreme conditions of heat and pressure created when nuclei of heavy elements collide. "These collisions," says Herman Grunder, director of LBL's accelerator division, "will momentarily create concentrations of neutrons and protons far bigger, hotter, and denser than any seen previously."

The achievement results from $6 million



Tracks left by some of the first uranium nuclei ever to be accelerated to nearly the speed of light. The dark streaks are the last one-half millimeter of three tracks as they came to rest in a special photographic emulsion. The bottom track shows a nucleus splitting into two lighter nuclei. The work was done at the Bevalac located at the University of California's Lawrence Berkeley Laboratory.

worth of modifications on two accelerators, the Bevatron and the SuperHILAC, which working in tandem are called the Bevalac. A new vacuum system was installed in the Bevatron, enabling it to handle ions of uranium, the heaviest naturally occurring element. And a new injector, dubbed ABEL, was built at the SuperHILAC to produce uranium and other heavy-element ion beams that are energetic and dense enough for acceleration. In practice, ions produced by ABEL are initially accelerated in the SuperHILAC. They then pass through a vacuum tube down the hill to the Bevatron and are further accelerated around its 400-foot vacuum ring.

Preparation for the successful uranium test began several weeks earlier, with the acceleration for the first time of ions of the elements xenon and krypton. Then on Monday night, May 10, scientists began "tuning" the Bevatron by accelerating certain iron ions produced in the superHILAC. Iron ions were used because they closely resemble the desired uranium-238 ions in one critical respect: they have a nearly identical mass-to-charge ratio.

Once the Bevatron was ready, the SuperHILAC was switched to producing uranium. Mid-afternoon on Tuesday, the SuperHILAC's detector indicated that uranium ions were indeed entering the vacuum tube, ready for the short dash down the hill. On reaching the Bevatron, the ions were further accelerated to about 90 percent of the speed of light, roughly 170,000 miles per second.

The first evidence that ions were making it through the Bevalac's combined acceleration process was obtained at 2:45 P.M., by "extracting" ions from the circulating beam and directing them toward a detector. Scientists then placed a special photographic film, called a nuclear emulsion, into the extracted beam. When the developed film was ready at 6 P.M., it clearly showed the spectacular tracks made by the passage of the uranium ions, providing final confirmation.

In line to use the new heavy-ion beams are numerous U.S. scientists, plus groups from France, Japan, Germany, Sweden, Canada, India, Switzerland, Egypt, and China. To measure the particles resulting from collisions of uranium and other large nuclei, they will use two new LBL detectors—the Plastic Ball and the Heavy Ion Spectrometer System (HISS)—which had been designed previously by scientists confident that the goal of accelerating uranium would ultimately be reached.—*Phila Rogers* □

The MGM Grand Hotel fire in Las Vegas, which claimed 130 lives. Sprinkler systems and thorough construction inspections, rather than new fire codes, are the best way to improve building fire safety. (Photo: Foundation for Fire Safety)

High-Rise Fires: Cutting Risks

"We will not solve fire problems in high-rise buildings with codes alone," according to Rolf Jensen, a fire-safety expert and engineer who operates a consulting company in Deerfield, Ill. "In fact, most code changes being made are overkill." The risk of fires in these buildings could be greatly reduced if the emphasis were instead on sprinklers and construction inspections, says Mr. Jensen.

At the spring meeting of the American Society of Civil Engineers in Las Vegas, he criticized building designers for failing to assume responsibility for fire safety from a project's beginning. He mentioned that the losses in the latest rash of large fires were compounded by "simple, identifiable fire-protection problems that should have been avoided in the design and construction of the building."

And there is no evidence that we have learned very much about fire-safety design. "The poor fire record has largely occurred in buildings that are not equipped with sprinklers," he said. "And the irony is that engineers are very capable of designing sprinkler systems, and architects can easily include them in their building plans." Poor inspection for fire-safety aspects—resulting from overburdening inspectors, glossing-over errors, and cutting corners in tests—have also resulted in "buildings that do not end up as conceived, designed, or bid," Mr. Jensen said.

Robert Fitzgerald of the Worcester (Mass.) Polytechnic Institute offered similar criticisms. "Because building teams don't really have a fire-protection engineer, you tend to find there is always 'somebody else' responsible," he said. He suggests assigning responsibility for fire safety to one group from the beginning to the end of construction.

Since World War II, changes in the design of tall buildings have contributed to increased fire danger, Mr. Fitzgerald said. These include the increased use of plastics and other synthetic materials that give off toxic fumes while burning, automatic elevators with heat-sensitive call buttons that tend to head for the floor of the fire, and suspended ceilings that allow flames and smoke to move freely without detection.

There's another problem with fire codes, too. Stanley Chesley, a leading Cincinnati attorney who has represented plaintiffs of the Las Vegas MGM Grand Hotel blaze and other fire disasters, warned that adherence to codes will not provide automatic protection against lawsuits for the architect, builder, or owner. He thinks building codes are "nothing more than a bare minimum," and that judges will hold builders and owners to higher standards.

Insurance is not always an answer, either. "Most engineers are drastically underinsured," said Mr. Chelsey, "and many policies do not guarantee legal representation." Nor will owners be protected by their corporation: "Any good lawyer can pierce the corporate veil."

Keep in mind, however, that high-rise blazes, while attracting public attention, are not the biggest fire threat the nation faces. Mr. Jensen stressed that fire statistics "clearly indicate that our major fire problem is in residential buildings."—*T.B.* □

San Diego County during 1980 flash floods. A new "real-time" automatic flood-prediction system, largest of 40 such systems in the nation, will save lives and money by providing earlier warnings and reducing false alarms. (Photo: Stephen McCarroll)

Help! Polymerics Afire!

Of the 130 deaths in the fire at the MGM Grand Hotel in Las Vegas a year ago, 100 were attributed to "smoke inhalation." But no one knows what was really inhaled; as usual, there were no autopsies of the fatalities. Indeed, hospitals had little information on which to base treatment of victims.

Like most modern hotels, the MGM Grand surrounded its guests with a rich assortment of synthetics; paper, wood, cotton, and wool are almost unknown in such an environment today. The combustion products of these synthetics are vastly more complex and apparently more toxic than those from natural materials. For example, Professor Y. Alarie of the University of Pittsburgh's Graduate School of Public Health concludes that the smoke from such polymeric materials is "six times more acutely lethal" than that from Douglas fir, and that some of the gases offer very special hazards such as "severe corrosion and severe pulmonary tract irritation at very low concentrations." Furthermore, Professor Alarie told the American Chemical Society last spring, the polymerics release their "smoke" far more rapidly than the natural materials.

Tests at the National Bureau of Standards described by Barbara Chernow Levin of its Center for Fire Research confirmed Professor Alarie's concerns. Carbon monoxide is usually considered the lethal product of fires in natural materials. But researchers determined that the levels of carbon monoxide released from any of 12 materials, both natural and synthetic, used in buildings are not high enough to kill.

Some of the materials, Dr. Levin said, were found to produce both carbon monoxide and hydrogen cyanide, which can act in an additive, but not synergistic, manner. For four materials, death could be caused by a combination of both chemicals. But in all the other cases, additional—unidentified—toxicants must be involved, and may sometimes be the chief villains.

Concluding the ACS symposium, Gordon Vickery, president of the Foundation for Fire Safety, asked for help from his audience of chemists. "We are up against a wide range of gases produced by materials never encountered in fires in the first half of this century. Eighty percent of fire deaths now result from the inhalation of toxic products." We need your help, he said, "to unravel the mystery of why so many people die in fires."—*J.M.* □

Fighting Flash Floods

Rain-laden clouds blanketed the San Diego area during January and February of 1980, triggering flash floods that caused nearly $120 million in damage. Such storms can't be prevented yet, but in May of this year San Diego County dedicated what may be the next best thing—the nation's largest "real-time" flood warning system.

Completely automated, the system gathers information on rainfall and stream flow to alert residents, businesses, farmers, and government agencies of impending floods. According to Carey Stevenson, civil engineer with the County's Department of Public Works, this information will reduce costly unnecessary evacuations and provide warnings two or three hours earlier than previously, so people can get out and emergency people can get in. In a nutshell, money and lives will be saved and "false alarms" will be reduced. (The system will also improve water-resource management: more than $4 million in stored water had to be released from one major dam during the 1980 flood.)

The system's 17 rain gauges and 20 stream gauges are spread over 4,300 square miles of mountain, desert, hills, and valleys. These gauges measure rainfall and water levels in the county's major river watersheds and reservoirs and transmit their findings to the County Operations Center in northeast San Diego. There the data are analyzed by computer using software and stream-flow models provided free by the National Weather Service (NWS). The models tell whether rain falling at the measured rate in each particular place, with rivers rising at certain rates, will result in flash floods—and where.

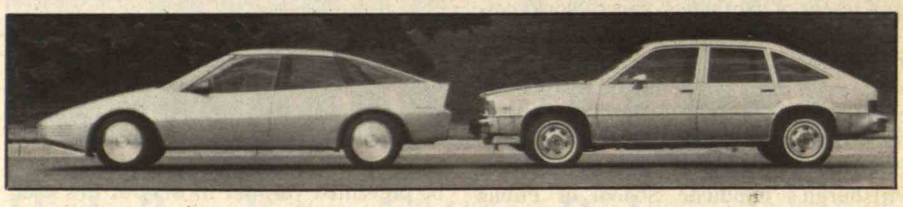
Even as the county's computer is at work, the data are also sent by telephone to the NWS California-Nevada River Forecast Center in Sacramento. There, larger computers with more sophisticated programs provide greater details about flood conditions for San Diego County, which are relayed immediately back. The same data are also used to help improve the center's regional forecasting ability. Planning for the system began in the spring of 1981, and it will be in full operation for the next storm season, beginning in November. Cost for the entire project: $270,000.

The system's special attraction is its relative simplicity. "We eliminated roughly half the electronics usually used in remote-monitoring systems," says Ted Roper of Sierra-Misco, Inc., of Berkeley, where the system was developed and produced. "We made it a 'transmit-only' system; that is, the field sensors keep regular watch on what's happening but transmit data only when there is some change in water levels."

Most field-monitoring networks have used "interrogated systems," in which a station responds only to a query. "This means you need both a receiver and transmitter at each site," says Mr. Roper. "But our system needs only a transmitter—powered by a very durable battery—which reduces both the cost and the chances that something might go wrong." The San Diego County system is the largest in a growing network of such flash-flood warning systems being coordinated by the NWS. The first was installed in California's Monterey County, following the Big Sur fire in 1977 that razed forests in three watersheds.

Called ALERT for "automated local evaluation in real time," these systems are now operating in or being planned for roughly 40 counties in California, Arizona, Colorado, Texas, Minnesota, Connecticut, and New York. The World Meteorological Organization is also installing ALERT systems in Pakistan and Honduras. Because of heavy rainfall, population patterns, and other local factors, some regions often face worse flash-flood problems than the U.S. WMO's goal is to bring monitoring systems to these nations.—*T.B.* □

General Motor's experimental "Aero X" improves fuel economy by 6 miles per gallon (combined city and highway driving) over the 1981 Chevrolet Citation, a typical "X-car." To obtain the same improvement through weight reduction, over 800 pounds would have to be removed. Among its drag-reducing features, the Aero X incorporates a molded plastic spacer inside the wheelhouse that fits closely over the tire and flexes with wheel movements.



Streamlining for Economy

Aerodynamic improvements will follow changes in engineering, size, and weight to become the wave of the future in increasing automotive fuel economy, says William H. Bettes of the California Institute of Technology.

At highway speeds, aerodynamic drag accounts for just over half of the fuel consumption in a typical 1980-model intermediate-size car. For a typical subcompact, the figure is a little higher. If the subcompact's drag were reduced by 10 percent, fuel economy would be upped by 5 percent; that same improvement would otherwise require a 16 percent weight reduction. (Drag increases as the cube of the velocity, so aerodynamics are a minor factor in saving fuel in slower urban driving, where reducing rolling friction and weight are the main routes to economy.)

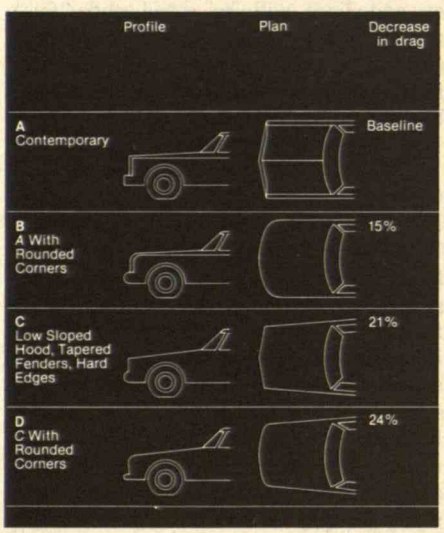
The biggest single factor in an automobile's aerodynamic drag is the size of its frontal area. American cars have been improving in that region ever since the 1930s, first through streamlining, then through lower profiles, and finally through downsizing. But there's still plenty of room for improvement, says Mr. Bettes. Substituting rounded corners for the hard front angles and slab sides of a typical 1980 intermediate-size car might reduce drag at highway speeds by 15 percent. Even with the hard lines retained, sloping the front end would cut drag by 21 percent at highway speeds.

There's less room for improvement at the back end of the typical 1982 car—especially the so-called "fastback." Such a design with tapered fenders and hard edges already causes 11 percent less drag than a typical "notchback." Ironically, hard edges aren't often used at the rear of American cars, where they are an aerodynamic advantage, in contrast to the front, where they are a disadvantage.

A full-length pan under an intermediate-size car would reduce drag at highway speeds by about 15 percent. If the pan covered only the area forward of the front axle, drag would be down by 9 percent—about the same effect as a "spoiler" suspended below the front bumper.

Air flow through the cooling system accounts for 5 percent of drag at 55 miles per hour, and the fact that this air "is left to its own devices to get out of the engine compartment" is an unnecessary source of friction, says Mr. Bettes. (Indeed, 40 years ago Professor Wunibald Kamm of Stuttgart proposed ducting the engine cooling air to exhausts at the base of the windshield, where it would dissipate a drag-causing pocket of turbulence.) Finally, open windows add about 5 percent to drag.

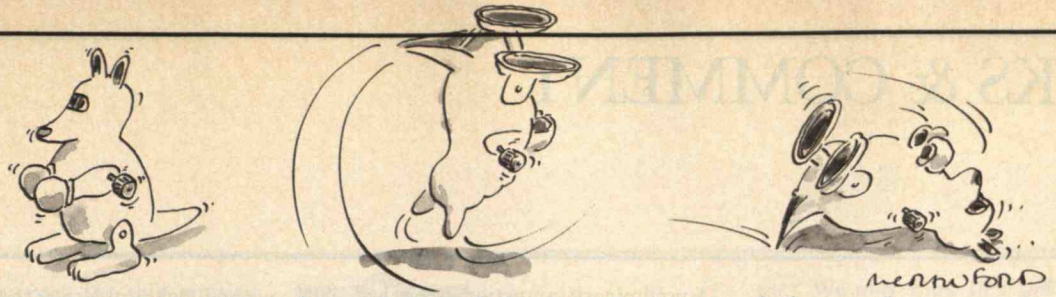
Wheelhouse space required for wheel movements during bumps and turns, and the side-panel bulges that accommodate the wheels of most cars, contribute significantly to overall drag. Several automakers are experimenting with aerodynamically positioned wheels, flush hubcaps, and partial wheel "skirts" to create a smooth side surface. Ford's European experimental car has a slim, low-profile tire designed to minimize drag associated with tires, which plough rather than slice through the air. "Aero X," General Motors' aerodyanamic test car based on the typical "X" vehicle, incorporates a molded plastic spacer inside the wheelhouse that fits closely—within about one-quarter of an inch—over the tire and flexes with wheel movements.



Improved front-end aerodynamics could reduce the drag of an intermediate-size American car at 55 mph by as much as 24 percent. A 40 percent weight reduction would be required to yield similar fuel savings—impractical in today's already "downsized" and "downweighted" vehicles.

Mr. Bettes told his audience at Caltech's Watson Lecture that he sees no reason why drag coefficients can't be halved in most American cars and trucks. Aerodynamic design, he says, is now "the easiest and most economical way to reduce the fuel consumption of our road vehicles." But Timothy Barrows of the federal Transportation Systems Center in Boston is not so optimistic. He says many of the easy aerodynamic improvements have already been made—such as redesigning front grills and side mirrors and repositioning license plates. Indeed, aerodynamic design has advanced so rapidly in the past decade that the drag coefficient—a number that indicates the aerodynamic efficiency of a vehicle's shape—of typical 1981 models was 20 percent below that of cars built in the 1970s.

What remains to be done are more subtle changes to fine tune the aerodynamics of cars. "Instead of first establishing appearance and then 'tuning' it for low drag," says Lloyd Nedley of General Motors, "wind-tunnel tests must figure in the basic design of the vehicle."—*J.M. and Allison L. Casey* □



Doomsday Machines Reconsidered

In the world of George Orwell's *1984*, "The search for new weapons continues unceasingly, and is one of the very few remaining activities in which the inventive or speculative mind can find any outlet." Whether the weapons are ever developed is of small importance. It is only essential that there be a permanent state of war between the superstates. Victory would bring no advantage because each side has "the same economy existing by and for continuous warfare."

Orwell's vision of the future (seen from 1949) was bleak, but he assumed that world leaders would eventually reject nuclear weapons. According to his "history" from the 1950s through the early 1980s, which included a brief period during which atomic bombs were dropped on industrial centers, "The effect was to convince the ruling groups of all countries that a few more atomic bombs would mean the end of organized society, and hence of their own power."

Yet although nuclear weapons have become far more numerous, sophisticated, and powerful than Orwell ever imagined, they have permitted a permanent state-of-war equilibrium similar to that in *1984*. Our war, of course, has thus far remained cold, but of considerably greater instability and risk. And what has remained permanent is the threat, with the weapons of one superstate deterring the other from initiating an exchange that most people assume would be concluded within days or even hours.

But the latest innovation from the Reagan administration would shatter this fragile deterrence by extending the concept of permanence to nuclear war itself—through weapons systems that would deliver devastating attacks and counterattacks against the Soviet Union over a long period of time. Reagan's Department of Defense didn't invent the idea, officials explain; they are merely the first to plan for it. Discussing the Pentagon's five-year defense plan revealed by the *New York Times* in June, Defense Secretary Caspar Weinberger offered the following rationale: "We must have a capability for a 'protracted' response—to demonstrate that our strategic forces could survive Soviet strikes over an extended period. Thus, we believe we could deter any attack. Otherwise, we would be tempting them to employ nuclear weapons to try to blackmail us."

To ensure the long-term survivability of such forces, military planners are literally thinking in-depth. According to a recent report in *Science*, "deep-underground missile basing," which some critics prefer to call by its acronym DUMB, is now being studied: ICBMs would be buried so far underground that Soviet missiles couldn't possibly destroy them. They would burrow to the surface sometime after an attack and, despite the already shattered state of the combatants, continue the conflict.

A deep-underground basing system would likely achieve its primary objective—invulnerability—but whether it would be effective or affordable is another matter. Given its dependence on new technologies operating in remote locations and uncertain postattack environments, the system would be unreliable. And given its scale and complexity—one concept, the "mesa-tunnel," would essentially be an underground version of President Carter's MX-shuffling network for the West—it would be outrageously expensive to build.

But out of the West comes another idea: J. Bart Czirr and E. Paul Palmer, both of the Physics and Astronomy Department at Brigham Young University in Utah, propose a "boomerang system" of small, unmanned submarines. Each sub would carry nuclear weapons of intercontinental range, and would be programmed to launch them against predetermined targets in the Soviet Union. Only a routine "all-is-well" message, periodically transmitted by American sources, would keep them from firing. The absence of such a message—presumably in the aftermath of a massive nuclear attack on the United States, when no authorized personnel were left to send it—would allow the system to fulfill its mission: weeks, months, or years after the attack, even after the country was utterly destroyed, it would retaliate.

Professors Czirr and Palmer acknowledge that their proposed system is a kind of "doomsday machine"—they prefer to call it a "weapon of retribution"—but they stress that it is relatively simple, efficient, and inexpensive and depends only upon well-established technologies. It is also, in their words, "a 'robotic alliance' that begins automatic action upon attack [and] is not susceptible to intimidation."

There is some nagging concern about whether Czirr and Palmer have considered the consequences of failure sufficiently and how such an automatic system might be confounded. For example, could the all-is-well signal be sent by the enemy? Could it be blocked by a terrorist group? Or could malfunctioning equipment block the signal without human intervention? Still, Czirr and Palmer propose their doomsday machine in an altogether different spirit from most other options. "Our present systems are conceived on the faulty premise of superiority, and that is the reason for frantic proliferation," they say. But if the United States and the Soviet Union *each* had such a doomsday machine, "trigger-happy tendencies" would be deterred because all nuclear weapons would become obsolete: "Only two systems need to be built; one on each side."

"I have been surprised at the unanimity with which the notion of the unacceptability of a doomsday machine is greeted," Herman Kahn observed in 1961 in *On Thermonuclear War*. "Except by some scientists and engineers who have overemphasized the single objective of maximizing the effectiveness of deterrence, the device is universally rejected." He could well have been referring to Czirr and Palmer, or to their less idealistic but possibly more pragmatic colleagues in the defense establishment. But Kahn added: "Many scientists believe that with the passage of time, doomsday machines will inevitably become both clearly feasible and much cheaper than I have suggested, so that the developmental gamble will be much less risky than it is today."

Though the stated intention is to deter enemy attack, deep-underground basing, and systems like it, are really *post*-doomsday. "Its capability," observes *Science* reporter R. Jeffrey Smith, "would not be needed until other U.S. weapons had already been expended and U.S. civilization had been turned to dust." Thus, he says, "the idea seems costly and irrelevant." But at least the missiles aren't set on automatic. In contrast, although a "robotic alliance" as proposed by Czirr and Palmer would be far less costly and complex and could well be the ultimate deterrent, its failure could *trigger* doomsday. The well-intended reasoning behind it may be simplistic and naive. Yet the scale of "continuous warfare" has now reached such a dangerous, near-doomsday level that the time for such concepts—at least, for seriously discussing them—may have come.—*S.J.M.* □

Born-Again Secrets: The Government and the H-Bomb

The Secret That Exploded
Howard Morland
New York: Random House, 1981, 288 pp.

Born Secret
Alexander DeVolpi, et al.
New York: Pergamon Press, 1981, 320 pp.

Reviewed by Gerald Steinberg

In 1951, Edward Teller and Stanislaw Ulam devised a new way to design thermonuclear weapons. This approach led J. Robert Oppenheimer to declare that the project had been altered from "a tortured thing that you could well argue did not make a great deal of technical sense"to something "technically so sweet that you could not argue about it." The Teller-Ulam principle enabled the United States to successfully detonate the first deliverable thermonuclear weapon, an invention that, according to Herbert York, "is the one truly central technological fact in all this that still remains secret."

In 1979, *The Progressive*, a magazine devoted largely to left-wing political causes, sought to publish an article written by free-lance writer Howard Morland that purported to reveal the design of the H-bomb and the Teller-Ulam principle. On March 8, 1979, the U.S. government went to court to obtain an injunction restraining publication. The government argued that the article violated the 1954 Atomic Energy Act by revealing "secret restricted data" and endangering national security. Attorneys, government officials, and some scientists argued that publishing the article would contribute to the proliferation of thermonuclear weapons. In opposing attempts to restrain publication, *The Progressive*, joined by the American Civil Liberties Union and many newspapers, argued that since Morland had not used secret sources, restraint of publication would violate the First Amendment.

A preliminary injunction was issued, and attorneys for *The Progressive* appealed. During these hearings, the the case gained a great deal of national attention. In an effort to demonstrate that the article included only material already in the public domain, a number of newspapers printed some of its essential ideas. In addition, it became apparent that the government had accidentally revealed classified documents while arguing its case, an action that was probably more damaging than the article itself. It soon became clear that the dam had broken, and the government dropped its appeal. Shortly thereafter, Morland's article was published.

Since then the controversy has been largely forgotten. But the important issues of government secrecy, weapons design, and the "public right to know" surrounding the case remain unresolved.

For example, why did Morland write the article in the first place? Why did the government confirm the validity of some of Morland's article rather than merely ignore it and leave the reader to try to sift out fact from fantasy? What was the logic, if any, behind the affidavits of James Schlesinger (head of the Department of Energy) and Harold Brown (secretary of defense), and why did Schlesinger personally call newspapers to argue the government's case? Finally, what are the long-term impacts? Did, as Brown argued, publication of the Morland article contribute to the capability of some countries (or even subnational groups) to make H-bombs? Did it lead to a popular outcry against nuclear weapons, as Morland expected?

Two books have now been published that deal directly with the case. Unfortunately, both are written by participants and reflect their prejudices. In *The Secret That Exploded*, Howard Morland, the author of the original article, relates his view of the public controversy and court case. *Born Secret* is written by four physicists at Argonne National Laboratory who advised and wrote affidavits for *The Progressive* and its allies. In addition to explaining the issues, the authors attempt to detail the political and technical implications.

The Morland book is a peculiar mix of confession, odyssey, and crusade. The author sees himself as a latter-day Don Quixote and portrays the case as a personal conflict with the government. The bulk of the book traces his journey in pursuit of the H-bomb secret. He seeks out retired technicians in New Mexico, nuclear-weapons installations such as Oak Ridge, and scientists in Cambridge, Mass. Throwing around technical jargon to give the impression that he knew more than he actually did, he extracted information from DOE officials and former technicians in the weapons program. His attempt to explain what he learned is confusing and often inaccurate, reflecting his lack of technical training. (His article in *The Progressive* contained many errors, and the errata that were printed later were not much better.)

Morland is politically naive. For example, he attributes the development of MIRVs (multiple independently targeted reentry vehicles) to an oversupply of uranium-235, and the decision to deploy neutron bombs as "nothing more than a way of maintaining demand for plutonium and to keep on reprocessing." In his strangely inverted view, the nuclear-weapons program is subservient to the government's "real" goal—promoting nuclear power. He trivializes the controversy surrounding nuclear deterrence by simply asserting that there are enough offensive nuclear weapons in existence and any more are unnecessary.

The most important issue Morland addresses is his motivation for publishing his version of the Teller-Ulam principle. He argues that ignorance has "hampered the efforts of the potentially large numbers of antibomb activists. . . . This ignorance was the result of secrecy. . . . So I developed a new strategy in my contest with the government—I would attack secrecy; if secrecy could be dismantled, then the opponents of nuclear weaponry would have a fighting chance." The H-bomb was the last great nuclear secret, and if it were revealed, "This bomb would be too real, too solid and heavy to be easily put aside. I would force it upon people's consciousness."

The last logical leap was not clear to everybody. Herbert York, while sympathetic to the cause of arms control, asked Morland why he needed to know what the inside of an H-bomb looks like. The damage these devices cause is the key issue, and knowledge of their internal organs is not necessary to perceive the effects.

In contrast, *Born Secret* is a relatively straightforward and measured discussion of the case. DeVolpi and his colleagues summarize the facts succinctly and present an understandable review of the technical issues. Their main concern is excessive government secrecy. In opposing the government's action, they argue that the information was, in fact, either in the public domain or easily deducible by "anyone who could make use of the information." Thus, secrecy only serves to inhibit informed public discussion.

ILLUSTRATIONS: ELIZABETH SLOTE

In building support for this position, they cite the impact of secrecy on the original decision to proceed with the H-bomb. They maintain that the secret internal debate was based on faulty assumptions that, had they been subject to public scrutiny, may have led to a more rational policy. They note that government officials today often use ostensibly "secret" information to influence public opinion. For example, during the annual budget debate, Pentagon "sources" selectively leak secret information on a new Soviet missile, space-based laser, or bomber to gain support for higher allocations. The authors argue that current public discussion of the Comprehensive Test Ban Treaty is also hampered by the lack of information on the design of thermonuclear weapons.

DeVolpi and his colleagues also focus on the question of whether the material presented by Morland was really derivable from or already on the public record. For its part, the government noted that even if Morland had derived the information without the help of the retired bomb technicians and DOE personnel, it was "born secret." Under the terms of the Atomic Energy Act of 1954, thoughts and information in the area of nuclear-weapons design and production are "classified at birth," although they may have been developed entirely without benefit of classified information. For the authors of *Born Secret*, this provision of the Atomic Energy Act is practically unenforceable and constitutionally reprehensible, and they advocate its repeal.

Most importantly, DeVolpi and his colleagues raise questions about government behavior. By arguing that the article was essentially correct, government officials gave the article credibility it otherwise would have lacked. The personal involvement of cabinet officials increased this endorsement, as did the inadvertent declassification of sensitive documents.

But this discussion also reveals the basic weakness this book shares with Morland's. Both assume that the "government" proceeds rationally and with a single purpose. However, political analysts have long realized that bureaucratic interests and simple incompetence often determine the outcome of political events. A careful analysis of the behavior of the principal actors is necessary to understand these events and their implications. □

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Stirring Up the Primordial Soup

Life Itself: Its Origin and Nature
Francis Crick
New York: Simon & Schuster, 1981, 192 pp., $12.95 cloth

Reviewed by Michael Riordan

The origin of life on earth seems an unlikely event, at least by the accepted canons of modern scientific thought. To be sure, there was almost certainly an abundance of small organic molecules—formaldehyde, simple sugars, even some amino acids—falling into the primeval oceans from an oxygen-free atmosphere. But the proposition that random collisions and interactions among these molecules, governed by Darwinian natural selection, could somehow generate complex, self-replicating chains of RNA, DNA and proteins still staggers the scientific imagination. No laboratory experiment has even come close to duplicating this amazing feat.

But cellular life did appear on the earth's surface less than a billion years after it had first cooled—and only a few hundred million years after the primeval oceans had formed. Fossils recently discovered in Western Australia provide fairly convincing evidence that colonies of bacteria were thriving in shallow pools and inlets about 3.5 billion years ago. And the oldest terrestrial rocks yet discovered—about 3.8 billion years old—contain carbon isotopes in ratios similar to those produced by living cells. It now seems plausible that self-replicating molecules or "organisms" appeared almost immediately (when compared with the 4.5 billion-year age of the earth) after conditions had first become favorable for life.

These and other discoveries of the past decade have caused a profound revolution in the study of life's beginnings. As recently as 1965, Nobel Prize-winning biologist James Watson could claim that "life first existed some 1 to 2 billion years ago in a simple form, possibly resembling bacteria." We now know that this statement is nonsense. Prokaryotes (cells with no nuclei, such as bacteria) existed here on earth at least 3.5 billion years ago, and eukaryotic cells (more complex, nucleated cells) first appeared some 2 billion years after that. What seems truly astounding, even paradoxical, is that life could appear so early in the earth's history, particularly when it took so long for the next major step in evolution—the advent of eukaryotic cells—to occur.

In *Life Itself*, Francis Crick (who shared the Nobel Prize with Watson for discovering the structure of DNA) proposes to resolve this seeming paradox with an idea drawn straight from the pages of science fiction. He maintains that primitive bacteria did not evolve here on the earth's surface. Instead, they were sent here in an unmanned rocket from another stellar system and deposited in the primeval oceans rich with organic molecules. From there it was a simple matter for these bacteria to feed on this primitive soup, and for all life as we know it to evolve.

Called "directed panspermia," Crick's hypothesis is the twentieth-century version of a theory first proposed in the late 1880s by Svante Arrhenius. He suggested that life on earth had begun when primitive spores drifted in from outer space. But unprotected spores could not have survived the radiation of a deep-space environment, and Arrhenius's "panspermia" theory fell into disrepute.

By hypothesizing that the organisms were enclosed "in the head of an unmanned spaceship, sent to earth by a higher civilization that had developed elsewhere some billions of years ago" Crick adds a tantalizing element of intentionality (an appeal to the supernatural?) to the origin of life on earth. Perhaps this "higher" civilization was doomed to extinction and wanted to preserve copies of its life forms elsewhere in the galaxy. We will never know for sure. But Crick makes some surprisingly plausible suggestions about the technology that might have been used to accomplish such a feat, a technology not that far in advance of our own.

The plausibility of directed panspermia, in fact, seems to be the main thrust of Crick's short book. He wants his hypothesis to be taken seriously—put on an equal footing with its rival, the "indigenous generation" hypothesis, which postulates that life appeared spontaneously on our planet. And Crick succeeds in this aim: scientists and other critics who emotionally decry the directed panspermia hypothesis should in-

stead get down to the difficult task of trying to disprove it.

Though scant and open to many different interpretations, evidence is growing that may eventually offer a definitive test of alternative hypotheses. One body of work (which Crick, to his discredit, ignores completely) by Carl Woese and coworkers at the University of Illinois seems particularly promising. By comparing sequences of nucleotides in the RNA of single-celled organisms, this group was able to establish a hitherto unsuspected category of life forms—archaebacteria—that may well be direct descendants of the earliest life forms. These "anaerobic" cells would have thrived in the oxygen-free atmosphere of the early earth. In effect, Woese's group uses RNA as a kind of "genetic fossil" that allows them to peer back through eons of evolution.

They also find evidence that all three cell groups—the archaebacteria, prokaryotes, and eukaryotes—probably descended in parallel from a common, universal ancester called the progenote. If true—and we are on very speculative grounds here—such a result would cast tremendous doubt on the directed panspermia hypothesis, which depends on the notion that life descended from a single group of bacteria. Of course, Crick could easily modify his hypothesis to claim that the alien rocket ships brought progenotes, not bacteria, but patchwork theories rarely, if ever, make good science. Further studies of such "genetic fossils" should help resolve this conflict.

A major problem with directed panspermia is that it puts the "true" origin of life beyond the realm of human knowledge. The theory smacks of religion, albeit religion cleverly dressed in the clothing of science. Unlike true scientific hypotheses, it offers few ways it can be disproved; it asks that you accept its edicts on faith. And in the proposal of an intentional origin for life on earth, directed panspermia parallels the Book of Genesis. Humanity can continue to regard itself as above nature, a "spiritual" entity somehow discontinuous with the "baser" world of mere matter.

If I learned any one thing in my years as an experimental physicist, it is respect for scientific paradox as a source of new human thought. Einstein's resolution of the paradox posed by the famous Michelson-Morley experiment is probably the best-known example of this. Not only did his theory of relativity profoundly alter the way scientists regard the universe; it also influenced human thought in such far-flung fields as religion, philosophy, and social theory. In the present controversy over life's early origins, it seems we are facing yet another paradox that promises rich new insight into the nature of existence. Its resolution will probably require that we abandon certain assumptions we are now making about the nature of life and matter.

Ultimately, the answers to these questions we will come only from an extensive, impartial examination of all the evidence that can be gathered. Right now, that science is still a fertile, open field. □

Michael Riordan is editor and publisher of Cheshire Books and coauthor of the Solar Home Book. *He received his Ph.D. in physics from M.I.T. in 1973.*

ath for the Masses

Algebra I: An Incremental Development
John Saxon, Jr.
Norman, Okla.: Grassdale Publishers, 1981, 444 pp., $12.60

Reviewed by Joan Baum

Algebra—the watershed subject. The dividing line between those who make it in math and those who don't. The point at which the chasm widens and science majors are confirmed, while those who suffer math anxiety and low scores transform their sense of incompetence into hatred. So when a new book is heralded as "the breakthrough in algebra" and claims to improve average test scores by 159 percent, teachers must take notice.

Although *Algebra I* is not readily available outside Oklahoma and the few schools that are using it in New York, New Jersey, and California, it has already provided quite a stir. However, the cause of the controversy is not so much the book as its author, who has antagonized the mathematics community, the U.S. Department of Education, and the six major publishers who rejected him. It's not just that Saxon promotes his high-school text aggressively, convinced he's doing good for the country, but that he's furious at the "self-appointed standard-bearers of the new mathematics who, with arrogant ineptness, have written the books from which teachers have been forced to teach for 20 years." And he's furious at the publishers who hire these "experts" as consultants.

By "new mathematics," Saxon does not mean the "new math" but rather the current emphasis on "mastery and spiral learning," which he thinks is abominable—the work of "pseudoexperts" who also think they're teaching fundamental concepts and logical processes. Nonetheless, in the opinion of David Kay, professor of mathematics at the University of Oklahoma, Saxon has "uncovered a problem that has grown out of the universal adoption of the 'new math' in our schools"—the use of textbooks that "continue to reflect an ultrasophisticated point of view compatible with the way seasoned, professional mathematicians look at mathematics." Which is not the way the masses do.

Meanwhile, as Saxon notes, national scores keep declining while those of students of his method go up, dramatically.

Saxon is a persistent self-promoter with a message. A former instructor at the U.S. Air Force Academy, now a mathematics teacher at Oscar Rose Junior College in Norman, Okla., Saxon spent 6 years writing a text some critics say will set mathematics back 600. He ignores the calculator, keeps to some old-fashioned terminology, and at a time when national mathematics associations are emphasizing problem-solving skills, cognitive processes, and learning strategies, insists on drill-and-skill and back-to-basics repetitive review.

His background and recent associations with *National Review* probably don't endear him to those who have encountered his blunt, almost military style. But there is a sense of honesty and openness that nonetheless adds credence to his outspoken claim that "my book can turn things around."

Some say it already has in Oklahoma. During the 1980-81 school year, 16 short tests of fundamental skills from *Algebra I* were given to students in 20 Oklahoma high schools; 519 used Saxon's book; 841 did not. The results, in the words of one participating teacher, were "outrageous": Saxon-taught students outscored other students by far.

What *is* the Saxon method? It has to do with emphasis rather than subject matter. Although Saxon does introduce certain

topics relatively early, such as signed numbers, negative exponents, and scientific notation, essentially his focus is on continuous review and small, "incremental" lessons (126 in all) rather than in topic chapters.

The Saxon style is ordered, clear, and visually attractive. The book is neat, so neat, in fact, that some say it constitutes "blind mindless drill." The charge is unfair. Here's Saxon: "We could now just give the rules for multiplication and be done with it, but let's try to get some feeling for why the rules are as they are." He takes care to explain key words and ideas and has an eye for potential trouble.

However, the book does have its limitations, particularly in its word problems. For example, a favorite word, "sciolism," which Saxon uses in a *National Review* article to bludgeon the "experts," turns up in the algebra test: "The sciolist headed for town at 30 miles per hour." Other word problems introduce suspect words in arbitrary contexts, such as "stolid" people and characters who are directed toward "redoubts" and "parapets." There are references to Achilles, Boesch, and Milton, and to brigantines and sable coats. Rather than striving for wit and archness, he should have reached for relevant examples that directly relate to students' experience. He should have used problems, says Joseph Malkevitch, head of the mathematics section of the New York Academy of Sciences, that show why students need to know algebra and that involve them in real-life situations.

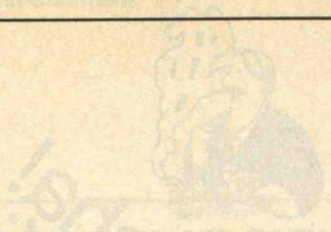
But in a field where there is nothing much new in textbooks, *Algebra I* is an important innovation. Algebra, Saxon says, "is a learned skill." In contrast to arithmetic, which has a substantial rote component, algebra—although it, too, has its memorized features—is not a rote subject. The distinction is important to those involved in math education.

Math teachers who emphasize problem-solving strategies and "cognitive skills" argue that rote features are worthless unless they are used to actually solve problems, and that it is in this area that high schoolers fail abysmally. Then again, many teachers are not good at teaching problem-solving skills, a more difficult subject than algebra. Thus, while good books can never take the place of good teachers, they can, and must, substitute for less-than-adequate classroom instruction.

At the last annual meeting of the American Association for the Advancement of Science, speakers sounded warnings about the "critical shortage" of trained high-school math teachers. The National Council of Supervisors of Mathematics reported that 26 percent are "uncertified or only temporarily certified to teach math." Saxon's book, therefore, comes at a propitious time.

Ironically, some of the Saxon controversy is generated by professors of this most logical discipline making an ad hominem case. But the controversy also results from genuine frustration on the part of those who serve the Queen of the Sciences on the outer grounds of the temple, teaching those who may never be its priests, nor even its half-willing servants, but on whom the life of the realm depends. Saxon's mission should be seen in this light. □

Joan Baum is associate professor of English at York College of the City University of New York and a faithful student of mathematics.



Space/Continued from page 14

to a different service. Use of such platforms would eliminate the need for multiple relays through several satellites. Such relays are frequently now required to send a message to its final destination.

Walter Morgan believes users will lease portions of such a platform while sharing electrical power, thermal control, and other utility services, much like individual merchants in a shopping mall. Such shared services and economies of scale could dramatically reduce costs and open up new services, such as electronic mail and pocket telephones. Direct-broadcast TV, in which programs are transmitted from satellites directly to individual homes instead of through local stations, is another promising possibility. Licensing of these systems was recently approved by the Federal Communications Commission.

Critics of multifunction platforms have argued that they will be inefficient because each one will have to be positioned at a compromise location in space. Also, control requirements would be dictated by the most demanding user, penalizing the others. Malfunction of an insignificant part could require replacement of the entire complex if earthlings are depending on that particular service. Only time will tell if the apparent advantages of multifunction platforms outweigh the disadvantages enough to encourage their widespread use.

In 1979, bureaucrats and communications technicians from all over the globe gathered in Geneva to allocate transmission frequencies and orbital slots to space-faring nations until the turn of the century and beyond. Because the participants believed that these resources were in short supply, squabbles quickly broke out between developed countries, who favored allocations based on "squatters' rights," and Third World countries, who believed that slots should be set aside for everyone. Fortunately, recent technical solutions to the problem of orbital overcrowding can open numerous new communcations channels in space, and the Geneva debate may ultimately prove academic. □

Automakers/Continued from page 67

fact that not all components of a declining industry are declining. In general, I would hope for a policy that on the one hand is informed about technological progress and on the other is highly responsive to regional constraints and needs.

About regions—if one goes to the steel-producing heartland of Ohio and Pennsylvania, as I have, one is struck by the social devastation wreaked by the decline of parts of a great industry. It seems to me absolutely necessary to work on reconstruction around the real needs of communities, to mobilize local resources and skills. That is very difficult to do at a national planning level. It's a socially delicate process involv-

ing public participation, but it's one that should be emphasized.

Barnett: Should we have a policy of reindustrialization, of "picking winners"?

Rothschild: I believe that to establish the basis for a strong industrial America in the 1990s and after, there should be a more aggressive government policy of encouraging investments that will create lasting and productive employment, social values, and export markets.

It's not at all clear that the market will allocate investment funds in this way. One serious problem has to do with how the technological dynamism that seems to be inherent in the goods-producing sector can be made inherent in other sectors of the economy.

Barnett: What sort of creative alternative to Fordist automation, which as you have written is based on a technology 50 years old, do you see occurring in the automobile industry? What will happen to the assembly line?

Rothschild: I think over the next 20 years or so its importance will decline, in the sense that a smaller proportion of the total labor involved in making a car will be performed here. This is partly because the assembly line itself will be more automated and partly because other parts of the process, which can be more readily directed by the equivalent of quality circles, will be emphasized.

M.I.T. studies of the machine-tool industry in Italy and Scandinavia show a strong correlation between workers' involvement and opportunities for creativity and the success of the particular region or industry in the most conventional economic terms.

My own view of an optimal outcome would be to rapidly automate the extremely dangerous and repetitive jobs and to find ways of using the creativity of individual workers and groups of workers in other areas so they can contribute actively to increasing productivity. □

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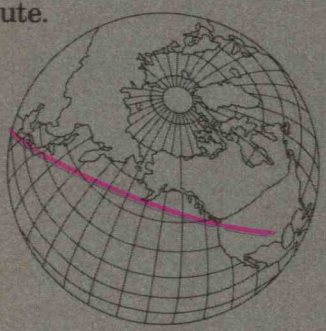
A Thai stewardess begins learning her job as a child. The smile, the shy charm, the belief that life is meant to be enjoyed, is as natural to her personality as the languid gracefulness with which she moves her body. It is, simply, the Thai way. And, many say, the most enjoyable aspect of Royal Orchid Service on the "Great Circle Express" route.



A straight line from Dallas/Ft. Worth to Seattle, Tokyo, Bangkok. Shortening your flight by more than a thousand miles. (Perhaps, regrettably.)

Thai

A Flight of Graciousness.

It's not what you think it is. (But you're close.)

This Volkswagen Jetta is often confused with another well-known German car.

And not just because their lines are so similar. But because their personalities are so similar.

After all, both were designed for the serious driver.

And both were built to handle the toughest driving challenges Europe has to offer. From Alpine curves with no guard rails to autobahns with no speed limits.

Turn these remarkable cars loose on a really demanding road and they'll both respond: With rambunctious performance. Razor-sharp handling. And a rarely-equalled feel for the road.

All of which brings up a rather obvious question:

Why should you choose Jetta over the other car?

Well, the fact is that Jetta has a feature that makes it considerably easier to handle.

A considerably smaller price tag.

Nothing else is a Volkswagen.